# THE EFFECTS OF VARIOUS INTELLIGENT TRANSPORTATION SYSTEMS APPLICATIONS ON THE TRANSPORTATION DISADVANTAGED GROUPS

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# ABSTRACT

## THE EFFECTS OF VARIOUS INTELLIGENT TRANSPORTATION SYSTEMS APPLICATIONS ON THE TRANSPORTATION DISADVANTAGED GROUPS

Many applications developed within the framework of Smart Transportation are developed to facilitate urban journeys and reduce costs. However, Intelligent Transportation Systems applications have not always been the applications that can be easily used by disadvantaged groups. With this study, it is aimed to develop technological suggestions to the discriminatory effects of ITS applications on the disadvantaged in general, transportation disadvantaged, and non-disadvantaged individuals, address to their special needs and the problems faced by individuals. Descriptive statistics, category analysis and One-way Anova Test were used as methods. According to the results, more than half of the disadvantaged individuals are unfamiliar with the concept of Intelligent Transportation Systems. The applications they use while traveling or in public transportation are the applications that they physically see, know, and use in their daily lifestyles in the city, or their use has become mandatory. Transportation disadvantaged groups generally know about ITS applications and use them actively during the day. It is understood from the problems observed in the city of Izmir that the development of spatial applications rather than mobile and web applications for the disadvantaged groups, the elimination of the malfunctions of Smart stops and Smart pedestrian buttons and the installation of new ones at smart stops, addressing the traffic congestion by making alternative transportation solutions, etc. In addition, smart stops, passenger information boards, smart passenger button, Green man, new map applications, Barrier-Free Smart Transportation, WeWalk, Horus, New public transportation vehicles should be implemented for the city of İzmir.

# ÖZET

## ÇEŞİTLİ AKILLI ULAŞIM SİSTEMLERİ UYGULAMALARININ ULAŞIM DEZAVANTAJLI GRUPLAR ÜZERİNDEKİ ETKİLERİ

Akıllı Ulaşım kapsamında geliştirilen birçok uygulama, şehir içi yolculukları kolaylaştırmak ve maliyetleri düşürmek için geliştiriliyor. Ancak Akıllı Ulaşım Sistemleri uygulamaları her zaman dezavantajlı grupların rahatlıkla kullanabileceği uygulamalar olmamıştır. Bu çalışma ile AUS uygulamalarının genel olarak dezavantajlı, ulaşım açısından dezavantajlı ve dezavantajlı olmayan bireyler üzerindeki ayrımcı etkilerine, onların özel ihtiyaçlarına ve bireylerin karşılaştıkları sorunlara yönelik teknolojik önerilerin geliştirilmesi amaçlanmaktadır. Yöntem olarak Tanımlayıcı istatistikler, kategori analizi ve Tek yönlü Varyans Analizi kullanılmıştır. Sonuçlara göre dezavantajlı bireylerin yarısından fazlası Akıllı Ulaşım Sistemleri kavramına yabancıdır. Seyahat ederken ya da toplu taşımada kullandıkları uygulamalar, şehir içinde günlük yaşamlarında fiziksel olarak gördükleri, bildikleri ve kullandıkları ya da kullanımları zorunlu hale gelen uygulamalardır. Ulaşımda dezavantajlı gruplar genel olarak AUS uygulamalarını bilmekte ve gün içerisinde aktif olarak kullanmaktadır. Bireylerin dezavantajlı hissettikleri durumlar genellikle erişilebilirlik, hareketlilik ve maliyettir. İzmir kentinde dile getirilen sorunlardan anlaşılan odur ki, Dezavantajlı gruplar için mobil ve web uygulamalarından çok mekânsal uygulamaların geliştirilmesi, Akıllı durakların ve Akıllı yaya butonların arızalarının giderilmesi ve akıllı duraklara yenilerinin takılması, alternatif ulaşım çözümleri yapılarak trafik sıkışıklığının giderilmesi vb. gerekmektedir. Ayrıca, İzmir kenti için ITS elemanlarından akıllı duraklar, yolcu bilgi panoları, akıllı yolcu butonu, Yeşil adam, yeni harita uygulamaları, Engelsiz Akıllı Ulaşım, WeWalk, Horus, Yeni toplu taşıma araçları uygulanmalıdır.

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# CHAPTER 1

# INTRODUCTION

In recent years, due to the increase in population and car ownership, traffic problems and time spent in transportation have been increasing in cities. As a result, there is a need for a more safe, affordable, sustainable, environmentally friendly, and fast transportation system. Transportation should be developed for purposes such as preventing accidents, reducing energy consumption, eliminating traffic congestion, using alternative transportation systems, increasing the use of public transportation, and solving the problems faced by users of public transportation. Information and communication technologies play an important role in the development of new transportation methods. Intelligent Transportation Systems (ITS) make use of electronic, information, and communication technologies to improve issues such as fuel consumption, safety, environmental pollution, traffic congestion, mobility, and accidents.

While transportation problems pose a major problem for healthy individuals, the problems encountered by disadvantaged individuals in transportation create even greater problems for them. People benefit from ITS applications in order to use transportation more safely, comfortably, and effectively. In this study, by examining the Intelligent Transportation Systems applications in the world and Turkey, the effects of existing ITS applications in Izmir on disadvantaged, transportation disadvantaged, and non-disadvantaged individuals were analysed, and recommendations were developed for the problems faced by individuals. The research questions of the study are listed as follows: 1. What are the effects of various ITS applications on disadvantaged groups? 2. What are the effects of various ITS applications on transportation disadvantaged groups? 3. What are the solution proposals for the problems faced by disadvantaged and transportation disadvantaged groups? Accordingly, the study is divided into five sections.

The first section of the study includes the introduction, where the purpose of the study, research questions, and thesis sections are explained.

In the second section, a literature review on ITS and disadvantaged and transportation disadvantaged groups is presented. The literature review examines the concept of ITS, its historical development, ITS architecture, classification of ITS, and its applications. The literature review on disadvantaged groups includes the definition of disadvantaged groups, studies conducted on disadvantaged groups, and an examination of the problems faced by disadvantaged groups. The literature review on transportation disadvantaged groups examines the concept and definition of transportation disadvantage, as well as studies conducted on transportation disadvantaged groups.

The third section of the study presents the materials and methods. Firstly, general information about the study area is provided, including information on the population and demographics of İzmir, as well as the transportation network, and ITS applications in İzmir are explained. Secondly, the scope of the study is discussed. Finally, the methodology of the study is explained, including information on the survey, study area selection, and data analysis.

In the fourth section, the results, statistical analysis, and discussion of the study were presented. In the results section, the findings from the data analysis were interpreted. In the statistical analysis section, the decision and interpretation of the hypotheses were presented by conducting an ANOVA t-test. In the discussion section, a general evaluation was made about the problems that disadvantaged and transportation-disadvantaged groups encounter while using ITS applications, and recommendations were developed to address these problems.

In the final section, the conclusion of the study was presented. This section briefly discussed the conclusions drawn from the study, the important points that need to be emphasized, the contributions of the study, and possible future research.

# CHAPTER 2

# LITERATURE REVIEWS

## 2.1. Intelligent Transportation System

Transportation, in its most basic form, is the movement of goods or people from one location to another. Transportation operations include land, air, and sea transportation, all of which have diverse operational structures and security measures [1]. Historically, animal power, sea routes, and mechanical vehicles have been used to conduct transportation activities. Transportation is not a sector that produces goods such as agriculture or services. However, the efficiency of the transportation sector implies that other sectors are also active [2].

As the world population increases over time, the number of vehicles on the road also increases. With the increase in vehicle usage, especially in large cities, many problems have arisen due to the formation of heavy traffic, which needs to be solved quickly. Existing infrastructures also struggle to meet the needs of the increasing population. Improvement in the transportation system is necessary to reduce the negative effects of these unmet needs on human life. Traffic density leads to an increase in transportation time, fuel consumption, high energy costs, and air pollution due to exhaust emissions [3].

The age of technology describes a time when information and communication technology will have a social, economic, and political impact on society, and society will become increasingly connected to the globalized world or more networked [3]. For many, building new roads or repairing old infrastructure is enough to improve the country's transportation system. However, the future of transportation systems will require the use of technologies such as sensors, microchips, and communication device networks that collect/distribute information about the functioning of transportation systems, in addition to concrete and steel [4]. At this point, the ITS concept, which aims to provide innovative services related to traffic management and different modes of transportation supported by advanced technologies, is encountered [5].

To make road transportation more sustainable and safer, it is necessary to develop a technological infrastructure that traffic management units, drivers, passengers, and pedestrians can continuously collect information about traffic and road conditions and at the same time, traffic control mechanisms can be used more effectively or implemented according to a strategic plan. The rapid development of information technologies today provides significant opportunities for the creation of such a technological infrastructure. This approach has led to the emergence of the Intelligent Transportation System (ITS) concept [6].

Intelligent Transportation Systems (STS) applications started in the 1960s. In the first period, Magnetic Loop Detector, Traffic Light Violation Detection Camera, Variable Message Signs, Speed Limit Signs, and ERGS-Electronic Route Guidance System emerged. In the 1970s, Speed detection radars, CACS-Comprehensive Automobile Control System, ARI-Autofahrer-Rundfunk-Information system, Automatic License Plate Recognition systems appeared. In the 1980s, Mobile speed detection and traffic cameras, SCATS-Sydney Coordinated Adaptive Traffic System, Road-weather information systems, Automatic navigation systems, electronic speed limiters emerged. In the 1990s, OGS-Automatic toll collection system, GPS-based navigation system, ISO TC 204 Intelligent transportation systems committee, Dynamic traffic light control systems, World Intelligent Transportation Systems Congress, ERTICO ITS Europe emerged. In the 2000s, Digital red-light camera systems, LED traffic lights, Blind-spot information systems, IEEE 802.11p vehicle-to-vehicle WiFi standards, E-call emergency information, management systems, Web 2.0 emerged. In the 2010s, Autonomous vehicle studies, connected vehicles and infrastructure, Electric vehicles, Data management applications have emerged. In recent years, ITS has progressed as a highly important and effective element at the national and international level [7].

Intelligent Transportation Systems (ITS) are defined as communication, information, and satellite technology-based solutions that aim to reduce traffic congestion and environmental impact of road transport and make roads safer [8]. In ITS applications, passengers, drivers, vehicles, infrastructure, control centres, and information and communication are connected to provide safer, more efficient, faster, and better transportation services while aiming to reduce external traffic impacts and save time [9].

Intelligent system solutions also offer important options for solving transportation problems. These systems help to create effective management and control processes by providing real-time information to management units about all transportation modes such as road, rail, sea, and air transportation [6].

ITS is a comprehensive system aimed at reducing traffic congestion and shortening travel time for individuals without changing the existing transportation infrastructure and network of the city. It was developed to provide internet-based data transmission, sensors that can be integrated with mapping systems, and software that enables communication between these two systems. ITS aims to optimize the transit of vehicles by directing them to the shortest route to their destination, thereby reducing traffic congestion, and ultimately saving people time spent on transportation [10].

According to the increase in the number and usage of cars, especially in developed countries, there is a need for more effective and organized road traffic, which has led to an increased demand and expected benefits for ITS applications. Therefore, the benefits of ITS can be listed as follows [10, 11];

- More active and efficient use of transportation systems,
- Reducing the risk of injury and death in accidents by reducing vehicle usage in traffic,
- Enabling disadvantaged people to participate in public transportation and meeting the transportation needs of both public transportation users and disadvantaged people in the shortest possible time,
- Increasing mobility,
- Making transportation services more accessible,
- Increasing safety and security for drivers, pedestrians, and roads,
- Contributing to the economy by reducing transportation costs and time,
- Solving transportation problems with more planned, faster, and cheaper methods,
- Providing an environmentally friendly, less harmful, and less energy-consuming transportation system.

### 2.1.1. Intelligent Transportation Systems Architecture

Solutions to traffic problems are produced through advanced information and communication technologies within the framework of ITS [12]. ITS applications are seen in various transportation systems such as drivers, traffic, passengers, emergency and accident systems, electronic payment systems, railway transportation, and freight transportation systems, except for those made for public transportation [13].

The AUS architecture is designed to meet the needs of users for defining, planning, and integrating subsystems on a common plane. Accordingly, the AUS architecture is as follows [14];

- It shows all working styles and system concepts in general.
- It is a specification of various technical equipment with transportation infrastructure-based elements that are intended to perform specific functions physically.
- It is a functional framework that specifies the functions that a particular system needs to perform in response to passengers' requests. It considers the relationships between the system, environment, and users using the datasets used.
- It explains the resources that help the flow of information between the system and its elements, in other words, the means of transferring information exchanges. The flow of information and data that combines the functions of the system and physical subsystems unites them in a holistic way.

Table 1. ISO ITS Architecture Service Areas and Groups
(Source: Yokota [15]).

| **Service areas** | **Service Groups** |
|---|---|
| **Passenger Information** | Pre-travel information<br>Information on the go<br>Travel services information<br>Pre-trip guide and navigation<br>Travel guide and navigation<br>Travel planning support |
| **Traffic management and operations** | Traffic control<br>Transport related accident management<br>Demand management<br>Transport infrastructure maintenance management |
| **Vehicle** | Improving the vision for transportation<br>Automated tool operation<br>Collision avoidance<br>Security<br>Pre-collision blocking |
| **Shipping transportation** | Commercial vehicle pre-authorization<br>Commercial vehicle administrative procedures |

**(cont. on next page)**

**Table 1. (cont.)**

| | |
|---|---|
| | Automatic roadside safety inspection<br>Security monitoring in the commercial vehicle cabin<br>Freight transport fleet management<br>Multi-model information management<br>Management and control of multiple model centres<br>Management of dangerous transport vehicles |
| **Public transport** | Public transport management<br>Demand sensitive public transport |
| **Emergency** | Transport emergency alerts and personal safety<br>Emergency vehicle management<br>Hazardous material and accident notices |
| **Electronic payment for transportation** | Electronic financial transactions related to transportation<br>Integration of transportation-related electronic payment systems |
| **Personal safety on the road** | Collective travel security<br>Increasing traveller safety<br>Increasing the road safety of the disabled<br>Smart junction and connections |
| **Monitoring weather and environmental conditions** | Weather monitoring<br>Environmental monitoring |
| **Disaster response management and coordination** | disaster data management<br>disaster response management<br>Coordination of emergency centres |
| **National security** | Monitoring and control of suspicious vehicles<br>Monitoring of strategic locations (Oil pipeline) |

### 2.1.2. Examples of Intelligent Transportation Systems Used in the World

It is known that more than half of the world's population now lives in towns and cities. It is predicted that this number will exceed 5 billion by 2030 (URL-1). One of the biggest problems of unplanned urbanization, which has developed along with population growth, is transportation. Therefore, Intelligent Transportation Systems (ITS) are utilized to solve the transportation problems in current cities and to take measures for future transportation problems.

In ITS applications around the world, the US, ERTICO, and Japan categorize them as the Advanced Traveller Information Systems (ATIS), the Advanced Traffic Management Systems (ATMS), the Advanced Vehicle Control and Safety Systems (AVCSS), the Electronic Payment Systems and Electronic Toll Collection (EPS & ETC), the Commercial Vehicle Operations (CVO), the Emergency Management Systems (EMS), and the Advanced Public Transportation Systems (APTS) [16].

Intelligent Transportation Systems utilize information and communication systems. These systems, which guide our daily transportation methods, aim to make transportation more effective and safer while considering environmental impacts. Intelligent transportation systems are effective in facilitating the management of large cities as part of smart cities. Many developed countries in the world utilize intelligent transportation systems to manage increasing traffic, achieve fuel savings, carry goods and passengers more effectively, protect the environment, and reduce carbon emissions. Detailed information on the work done by some countries in the field of Intelligent Transportation Systems in the world is provided below.

#### 2.1.2.1. Japan

Japan, which currently has the world's largest economy, has set advanced goals in the field of Intelligent Transportation Systems (ITS). Research and development studies on ITS are conducted by ITS Japan. Their strategies and action plans aim to have the world's safest transportation and roads. Therefore, they prioritize developing measures to protect human life, prevent accidents, eliminate damage caused by accidents, increase transportation safety, and raise public awareness sustainably [17].

In recent years, efforts have been made, and continue to be made, in Japan to reduce traffic congestion and resulting accidents using ITS technologies. These accidents actually occur due to delays in decision-making and identification processes of elderly drivers, as society rapidly ages. Preventive measures against accidents need to be taken for elderly drivers. ITS applications initially began in the late 1960s with signal controllers and traffic control systems and later became widespread with the electronic toll collection systems in the 1990s. ITS technology has now progressed even further with the emergence of advanced infrared signals. Additionally, Japan ranks fourth in terms of $CO_2$ emissions in the world, accounting for 4.8% of global emissions. Transportation systems make up 20% of this. Japan has been a pioneering country in the implementation and development of information and communication technologies to reduce traffic congestion compared to other industrialized countries [18].

Japan's goals in ITS applications are to ensure highway traffic flow and safety, benefit from information and communication technologies, be sensitive to traffic and the environment, and increase the welfare of society. Additionally, in Japan, the priority is to provide transportation safety, ease of use, and accessibility for elderly and disabled individuals, strengthen and build infrastructure such as earthquake-resistant tunnels, bridges, and roads, develop emergency management systems, and implement multimodal transportation and integration systems [17]. The main subsystems of ITS applications in Japan are as follows [19];

- Advanced Mobile Information Systems (AMIS) transmit information about traffic congestion and travel time collected at Traffic Control Centres to drivers through Vehicle Information and Communication System (VICS). Information is conveyed via roadside traffic information display panels and radio communication.
- Infrared Vehicle Detector detects vehicles operating at any point in Japan and communicates with in-vehicle equipment to provide information for each system.
- Dynamic Route Guidance Systems (DRGS) direct drivers to the shortest route to prevent and distribute traffic congestion and increase driving comfort.
- Driving Safety Support Systems (DSSS) use roadside sensors to detect traffic conditions that drivers may have difficulty seeing and alert drivers, thus preventing traffic accidents due to careless monitoring and driving.
- Public Transport Priority Systems (PTPS) minimize waiting times at intersections for buses by extending or shortening green light durations through Traffic Control Centres. The aim is to encourage people to use public transport instead of private vehicles.
- Fast Emergency Vehicle Pre-emption Systems (FAST) is a system established to enable emergency vehicles to reach accident sites more quickly and prevent secondary accidents during their arrival. This system monitors emergency vehicles through Traffic Control Centres and reduces the duration of red lights and increases the duration of green lights along their route.

- Pedestrian Information and Communication Systems (PICS) provide voice information about intersections and signals to many individuals, including the elderly and disabled, making it easier for them to cross intersections safely and carefully.
- ITS efforts are conducted under the names Advanced Highway Systems Initiative, Advanced Security Vehicle Initiative, and Smart way.
- In 2014, the Automatic Driving System Research Program entered the incentive program. This program is called the reduction of traffic congestion and fatalities due to accidents, development of autonomous vehicle systems, international cooperation for urban transportation, and development of next-generation technologies.

In addition to all these developments, recommendations were made for ITS at the World ITS Congress held in Tokyo in 2013. These recommended topics are shown in the table below [20],[21],[22].

Table 2. Recommendation Titles for ITS
(Source: Morimoto [20]).

| **1. Encouragement of Practice** | **2. Dissemination of Technology to Society** | **3. Responding to Social Challenges** |
|---|---|---|
| • Advanced Navigation System<br>• Automatic Fundraising System<br>• Safe Driving Support<br>• Traffic Management Optimization<br>• Road Management Activity<br>• Public Transport Support<br>• Commercial Vehicle Efficiency<br>• Pedestrian Support<br>• Emergency Vehicle Operations | • Advanced Security<br>• Facilitating and Environmental Load Reduction<br>• Enhanced Comfort<br>• Regional Activation<br>• Foundation Development and Internationalization | • Realizing Sustainable Mobility |

### 2.1.2.2. Singapore

Despite being a highly densely populated country, Singapore is one of the rare countries where traffic congestion and air pollution are not observed due to a low number of vehicles per capita. This is due to the high price of the vehicle usage permit. As a result, people use public transportation methods such as buses, trains, bicycles, taxis, and walking more actively than private cars. Singapore is the first smart country that aims to use technology effectively. It is the first city to use Electronic Road Pricing (ERP) among ITS applications to alleviate road congestion. Subsequently, the implementation of Intelligent Transportation Systems and air-conditioned integrated transportation centres was initiated. In Singapore, public transportation systems were weak in terms of passenger satisfaction due to population growth in 1965 [23].

The ITS infrastructure in Singapore covers 160 km of highways and road tunnels. In these areas, hundreds of sensors, devices, and cameras collect information about travel times, traffic flow, and road demand, providing information on the shortest route to take. Singapore conducts R&D studies for Autonomous Vehicle Systems in the public and private sectors. They have also begun trials for autonomous driving. Various ITS applications in Singapore are listed below [24],[25];

- i-Transport initiated the Integrated Transport Management System (ITMS) project in 1997. It is a platform where all ITS management is integrated, providing traffic monitoring, incident management, tunnel and expressway monitoring, traffic signal control, and traffic consultancy services.
- The Expressway Monitoring and Advisory System monitors traffic on highways and alerts people in case of accidents.
- The Green Man Application, disabled and elderly individuals need longer time on road crossings. Thanks to this application, it extends the transition times for disabled and elderly individuals.
- -Eyes is an intelligent surveillance camera system that monitors traffic events at selected intersections.
- The Green Link Detection System controls all traffic signals for green time as traffic flows change. Additionally, it is a system installed to intelligently, adjustably, monitor, regulate, and optimize roads.
- The Speed Indication Device is a sign that warns drivers based on their speed.

- The e-Traffic Scan is a system that provides information to taxi drivers based on GPS to ensure a smooth journey.
- The Parking Guidance System (PGS) shows the real situation of parking spaces in large shopping centres and central business districts to reduce traffic congestion.
- The Traffic Message Channel (TMC) tracks traffic and provides real-time updates to drivers through electronic messages.

Singapore has impressive traffic congestion rates worldwide thanks to its current ITS applications. The aim of Singapore's ITS is to meet transportation challenges in a coordinated and systematic manner to achieve smarter urban mobility in the future.

### 2.1.2.3. USA

The US is one of the leading countries in the field of ITS and is making serious investments and plans. The ITS vision of the US Department of Transportation is "Transforming the Way Society Moves". The ITS mission appears to be conducting R&D and education activities using information and communication technologies to enable people to travel more comfortably and safely [17].

In the USA, more than 6 million traffic accidents occur, mostly due to human errors by drivers. In addition, 28% of greenhouse gas emissions in the USA come from the transportation sector. The fact that the amount of greenhouse gas emissions caused by transportation is increasing faster than other sectors is a serious issue that needs to be addressed [26].

Although ITS applications have become a part of our lives in recent years, the first electric traffic signals were actually used in Cleveland, Ohio, USA in the 1930s [27]. The Electronic Road Guidance System in the USA was implemented in the 1970s as the first example of an Intelligent Transportation System (ITS). In addition, the US Congress enacted the "Intermodal Surface Transportation Efficiency Act (ISTEA)" in the 1990s. TEA-21 (Transportation Equity Act for the 21st Century) was formulated as a project based on ISTEA in the 1990s [28].

The USA Department of Transportation coordinates ITS through the Research and Innovative Technology Administration (Rita). The ITS components are especially phone data broadcasting, the Clarus Initiative, IntellidaR, Cooperative Intersection Collision Avoidance Systems, Next Generation 9-1-1, Emergency Transportation Operations, Congestion Initiative, Integrated Corridor Management Systems, Mobility Services for All Americans, and Electronic Freight Management [29].

There are several ITS (Intelligent Transportation Systems) applications in the US, as listed below [30],[31],[32]

- Traffic movements are under control with Point detection applications that monitor all traffic in the region. These applications have been used since the 1960s. These applications consist of video cameras and video processing systems, radar technologies, inductive loop systems, laser technologies, LED (Light Emitting Diode) detectors, infrared detectors, magnetometers, mobile phones, Bluetooth, and wireless sensor networks.
- It is desired to increase safety and security in public transport by monitoring the movements of the passengers in the vehicle, the driver's behaviour, the condition of the vehicle in traffic with the cameras placed on the public transport vehicles. Another tracking system called “G-Force” gives a warning in case of collision of buses used in public transportation, and records situations such as sudden turns, hard braking, and sudden acceleration into the system. The purpose of this system is to help analyse driver movements better, reduce insurance costs, identify the main problems encountered in vehicle repair, reduce accidents, and protect against lawsuits against public transport operators.
- Passenger information system is made at the stop where the journey starts or before the journey, at all stops where the journey is continued, inside the vehicle and in places where there is a park-and-drive application. This system uses SMS (Short Message Service), smartphone applications, DMS, fixed or mobile internet, interactive voice response systems and social media.
- Cooperative Intelligent Transport Systems (C-ITS): These systems are currently the focus of research in the USA, and the architecture is being updated accordingly. C-ITS enables the provision of a more advanced and high-quality service level between two or more sub-components of intelligent transportation systems (pedestrians, vehicles, road edges, and centres). Its most significant benefit is in ensuring road safety.

- The US has focused its efforts on Cooperative Intelligent Transport Systems (C-ITS) systems. In this system, over 80 federal programs finance human service transportation for "Disadvantaged" individuals, including aging populations, individuals with disabilities, low-income individuals, and military veterans. The eligibility rules for this program are different, and individuals may be eligible for multiple programs. The USDOT has launched mobility services for all Americans to promote better coordination of human service transportation at the federal level.
- Dynamic message signs (DMS) and highway advisory radio systems: These systems provide information to vehicles and drivers on the move.
- Ramp meter systems: These are traffic light systems that help control the controlled reduction and increase of congestion in the traffic of vehicles joining the highways from side roads.
- The Green routing is a vehicle system where people get information about the shortest and most efficient route in terms of fuel before they go where they want to go. In addition, The Connected Traveller project is designed to maximize the accuracy of the behaviour of drivers responding to immediate feedback and incentives to increase the energy efficiency of personal travel and the overall transportation system.

The strategies of Turkey in the field of ITS for the near term are to provide accessible transportation, sustainable mobility and environment, economic competition, road and driving safety. For the long term, these strategies involve the proliferation of electric vehicles, widespread deployment of C-ITS infrastructure for uniform payment in multimodal transportation, creation of integration systems, preparation for the transition to semi-automatic driving, encouragement of ITS investments, development of the market, and promotion of R&D [17].

### 2.1.3. Examples of Intelligent Transportation Systems Used in the Turkey

With rapid urbanization, population growth, and an increase in car usage, there has been an increase in traffic problems. The development and widespread use of ITS have made traffic management and control more efficient and easier. Furthermore, developed countries aim to direct people towards public transportation as a basic approach in transportation. This is because ITS applications provide people with comfortable, efficient, and safe travel. According to the areas of use of ITS applications in our country, the applications can be classified under the following headings [17];

- Passenger Information Systems,
- Traffic Management Systems,
- Public Transportation Systems,
- Electronic Payment Systems,
- Cargo and Fleet Management Systems,
- Driver Assistance and Safety Systems,
- Accident and Emergency Systems,
- Railway Operation and Management.

### 2.1.3.1. Passenger Information Systems

Advanced passenger information systems are one of the most widely used ITS applications. They involve collecting data both at home or in the office and in the vehicle, analyzing it, and creating travel plans [33]. Advanced passenger information systems are real-time travel and traffic information systems that provide passengers with information such as route recommendations, accidents, weather conditions, congestion or road work, route planning, and timetables for drivers [4]. These systems enable passengers to make safer and more efficient journeys by using alternative travel plans with the help of geographic information systems [34]. One of the most important features that make advanced passenger information systems effective is their ability to provide real-time information. To achieve the desired impact, it is undoubtedly dependent on simultaneous information flow. The elements that need to be used to inform drivers and passengers are listed below [33];

- Route selection,
- Journey planning,
- Route guidance,
- Passenger information service,

- Location finding and display service,
- Listed as road guide.

#### 2.1.3.1.1. Mobile and Web Traffic Information Applications

The mobile and web traffic information applications are good examples of ITS applications. Istanbul Metropolitan Municipality's İBB Cep Trafik application is a good example for web and mobile applications as it provides real-time traffic information. Another example is the web and mobile application (KGM Turkey Traffic) of the General Directorate of Highways (KGM). The website provides the most suitable route and alternative routes, closed roads, and satellite and vector maps for intercity passengers. The mobile application provides information on road conditions, route analysis, and OGS/KGS violations [13].

#### 2.1.3.1.2. Route Planning

These applications can also be evaluated under the heading of Smart Public Transportation Applications, but they also include special transportation feature information, and in this study, they will be evaluated under this heading. Applications such as İBB CepTrafik, Google Maps, Yandex Maps, Moovit, and mobile/web applications created by metropolitan and provincial municipalities are used for passengers' route planning.

#### 2.1.3.1.2.1. IBB CepTrafik

The İBB CepTrafik application is a service that provides users with real-time information on Istanbul traffic conditions through density maps and live camera footage, as shown in the figure. Some features of the personalized İBB CepTrafik application are;

- The application provides access to real-time traffic congestion information,
- Instant image capture is possible with the multiple cameras viewing feature,

- There is a weather service and infrastructure available,
- Electric charging station data is available [35].


Figure 1. IBB Cep Trafik Application
(Source: CepTrafik [35])

### 2.1.3.2. Advanced Traffic Management Systems

The increase in travel demand due to the construction of new alternative roads is not sufficient to meet each other's needs. Therefore, instead of building new roads, it is necessary to improve the management of existing roads and their infrastructure [33]. Among the advanced traffic management systems that can be used to improve the management of existing roads, there are traffic control systems and highway management. These systems are used to manage and regulate traffic in the city [34, 36]. By using these systems, information flow to traffic management and coordination units is provided to make traffic more efficient [37].

Sensors and cameras are used to collect data in these systems. After the collected data is transferred to the traffic control center, it is then transmitted to passengers and drivers [13]. With these systems, passengers can have high-quality trips, reduce traffic congestion, and respond more quickly to emergencies on the roads [38]. The following elements are used in advanced traffic management systems [39];

- Highway radio,
- Vehicle-based systems and radio for work zone and crash information,
- Getting travel information before travel with television, radio, and in-vehicle navigation,
- Road guide,
- Roadside and overhead variable message signs,
- Traffic signals and phase timing.

### 2.1.3.2.1. Dynamic Traffic Lights

The "Green line," also referred to as green corridors, is an event that ensures the continuity of traffic flow by allowing a vehicle traveling at a normal speed on arterial roads to encounter green lights at all intersections after passing through one green light. However, it is not always possible to ensure the "Green line." As a result, traffic congestion continues to increase with frequently congested intersections [13].

### 2.1.3.2.2. Electronic Monitoring Systems (EMS)

As part of traffic control, Electronic Monitoring Systems (EMS) developed by municipalities to control traffic flow, prevent traffic violations, prevent accidents, ensure the safety of life and property, and optimize all urban traffic by detecting vehicles that disrupt traffic regulations can be cited as an example. EMS consists of sub-components such as red light violation detection system, safety lane violation detection system, speed corridor violation detection system, parking violation detection system, tramway violation detection system, pedestrian path violation detection system, wrong-way violation detection system, preferential road violation detection system, mobile EMS violation detection system, and garbage detection system [13].

## 2.1.3.2.3. İZUM

The İzmir Metropolitan Municipality has developed the İzmir Transportation Centre (İZUM) which includes features such as traffic monitoring cameras, smart intersections, measurement and monitoring systems, speed corridors, and violation detection systems. The web and mobile application of İZUM offers users features such as traffic flow and density, the most suitable route selection, real-time images from installed cameras, accidents and road works, travel delays, and parking lot occupancy. Additionally, all streets and intersections are monitored with the smart traffic application. As a result, waiting times at intersections are not predetermined but are automatically adjusted according to the current traffic conditions, leading to safer vehicle and pedestrian traffic, reduced travel times, increased road capacity utilization, reduced traffic build up and waiting times, and observation and control of traffic violations[40].

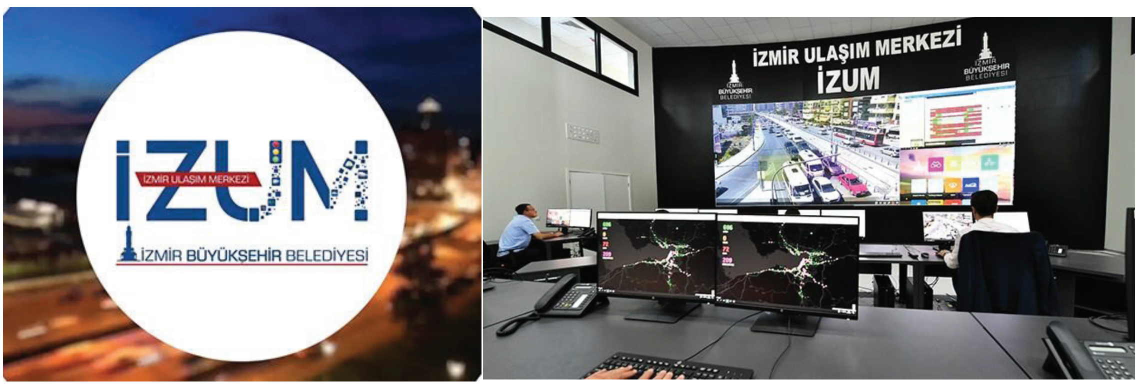


Figure 2. Izmir Transportation Center (İZUM)
(Source: IBB [40])

## 2.1.3.3. Smart Systems for Public Transportation

The use of ITS provides significant advantages in terms of time management and energy consumption, and to increase these advantages, people need to be directed towards public transportation. This is because public transportation can help reduce carbon dioxide ($CO_2$) and greenhouse gas emissions, and minimize the harm to the environment caused by energy consumption [41]. Public transportation vehicles use only about 20% of the energy used by automobiles. Additionally, the use of public transportation by people can significantly reduce traffic congestion [42],[43].

For public transportation-oriented ITS applications, advanced passenger information systems, advanced traffic management systems, on-board control systems, and commercial vehicle options are expected to be used [34].

## 2.1.3.3.1. Advanced Passenger Information System

Passenger Information Systems and electronic ticket transactions are the most commonly used ITS applications in public transportation. The aim of passenger information systems is to encourage the use of public transportation and facilitate its development by enabling better use of time and energy for passengers. Today, the most widely used passenger information systems are smart stops. Contactless smart cards are used for payment in electronic ticket transactions for transportation [13].

## 2.1.3.3.1.1. Smart Stops

Smart stops are systems that show the arrival times of buses at bus stops for passengers waiting at the stop. The aim is to minimize waiting times for passengers at stops and to enable passengers to choose their vehicles by taking into account the estimated arrival times of the approaching vehicles [12]. This system works by calculating the approximate time for the bus to approach the stop with GPS location information obtained from the buses in real-time and sending this information to the passenger information screens at the stops [44]. Smart stops can be seen in many metropolitan and provincial municipalities in our country as well. Istanbul, Ankara, and Izmir were the first cities to start using them.


Figure 3. AkyolBil Project
(Source: Akyolbil [45])

## 2.1.3.3.1.2. Smart Transportation Cards

There are various examples of Smart Transportation Cards used for various purposes and with various technologies in many countries around the world. Today, electronic ticket transactions are one of the ITS applications used in public transportation by many metropolitan and provincial municipalities. It started as "Akbil" by the Istanbul Metropolitan Municipality and continued to be used as "Istanbulkart". Later, it was also introduced as "Ankarakart" in Ankara and "Izmirim Kart" in Izmir [13].


Figure 4. Istanbul, Ankara, and Izmir Transportation Cards
(Source: İstanbulkart [46],Ankarakart [47],Izmirkart [48])

## 2.1.3.3.1.3. Mobile/Web Applications

With the increase and development of smartphone and mobile internet usage in our country, different applications have been started to be used for passenger information in Smart Transportation System applications. With these applications, users of public transportation can access information such as stop information, route information, departure times, estimated arrival times of buses, and city card loading transactions on public transportation lines. In addition, they have features such as showing how long it takes to reach the desired destination with which public transportation, providing detailed information about routes and stops, sending notifications about changes, and receiving complaints and requests related to public transportation services via instant messaging [44, 49]. In our country, "MobİETT" is used by Istanbul Metropolitan Municipality, "EGOCepte" is used by Ankara Metropolitan Municipality, and "ESHOT Mobil" is used by Izmir Metropolitan Municipality as a passenger information system.

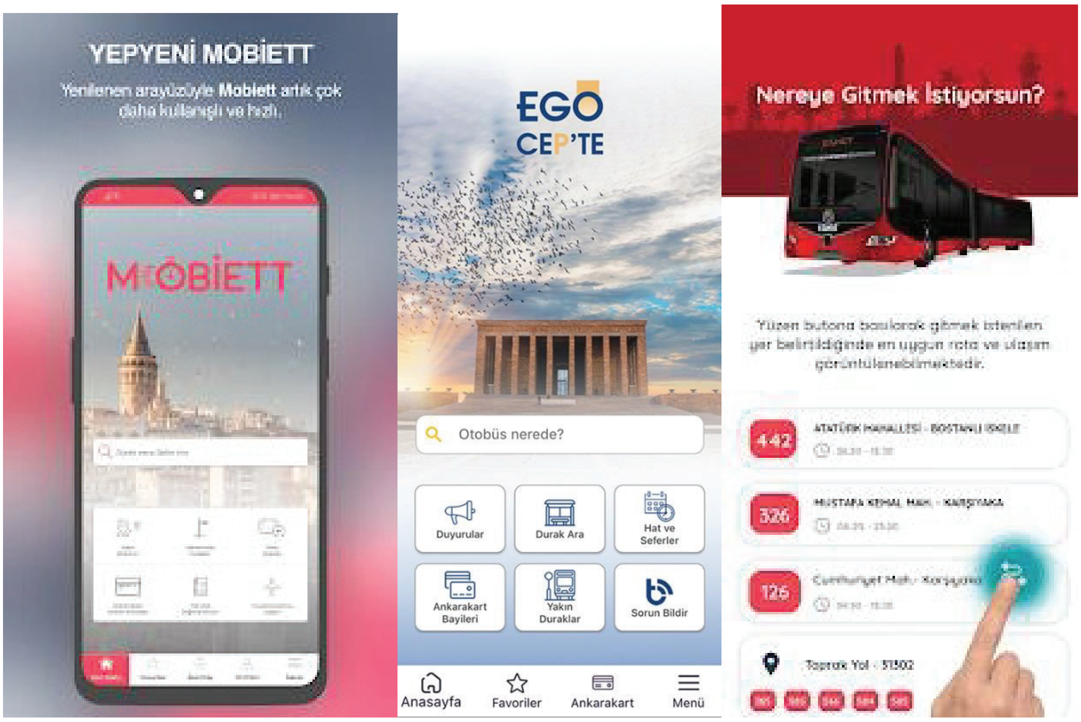


Figure 5. MobiETT, EgoCep, ESHOT Mobile applications
(Source: Mobiett [50],EgoCep [51],ESHOTMobil [52])

### 2.1.3.4. Electronic Payment Systems

Electronic Payment Systems refer to systems that allow vehicles to electronically pay tolls for using toll roads or bridges [53]. These systems deduct toll charges from the prepaid balances of drivers during their passage on the toll road. Electronic Payment Systems are essential in transportation systems of countries. Dedicated Short Range

Communication (DSRC) is the most commonly used payment application. Charges can be made using an effective in-vehicle device or a tag attached to the windshield [4]. Electronic toll collection systems have increased the efficiency of toll collection and reduced labor costs [54]. This system has provided drivers with time savings, reduced traffic congestion, and improved production and fuel economy [26, 55].

In our country, Electronic Payment Systems are used as Fast Pass System (HGS), Automatic Pass System (OGS), and Card Pass System (KGS). Initially, Card Pass Systems were used. However, to prevent traffic congestion on toll roads and bridges, and to provide drivers with the service at the cheapest and shortest way possible, Fast Pass Systems have been implemented [13].

Figure 6. Rapid Pass Systems (RPS) and Automatic Pass Systems (APS)
(Source: HGS [56],OGS [57])

### 2.1.3.5. Cargo and Fleet Management Systems

Freight and fleet management systems are a type of AUS commonly used by the private sector. These systems are quality programs that assist in planning and determining the optimal load status of a fleet. The program helps to monitor and manage a load during the process up to its destination [13].

In ITS applications, freight and fleet management systems include traffic signals on highways focused on traffic control devices, ramp measurements, and variable message signs providing information to drivers about highway or traffic conditions. These systems are operated in traffic coordination centres. Traffic coordination centres are established to detect accidents, hazardous weather events, or other road hazards. They use information technologies that connect with vehicle probes, cameras, message signs, sensors, roadside equipment, and other devices to avoid disrupting traffic flow on the highway [4].

### 2.1.3.6. Driver Support and Security Systems

Driver support and safety systems are a type of ITS that provides drivers with a safer and more efficient driving experience, enhancing vehicle control. Vehicles use built-in sensors along with digital maps and other computer data to understand their surroundings [58]. These systems are connected to in-vehicle ITS telematics systems and mobile communication technologies. Applications of in-vehicle AUS and V2V (Vehicle-to-Vehicle) / V2I (Vehicle-to-Infrastructure) communication technologies include traffic-sensitive dynamic routing, intelligent parking guidance, and traffic alert systems [59]. These technologies use cellular data channels, cloud technology, wireless networks, and DSRC [26].

### 2.1.3.7. Accident and Emergency Management Systems

Accident and emergency management systems involve notifying units in all events, especially traffic accidents on highways, and managing the resulting damage. The success of the process depends on preventing fatalities and minimizing material damage [13]. eCall is the most important application of accident and emergency management systems in the EU. With the eCall application, emergency assistance is immediately provided to drivers in the event of a collision in any part of the EU [60]. In fact, even if the occupants of the vehicle lose consciousness, the coordinates, vehicle information, and other necessary information are automatically reported to the Emergency Call Centre [13].

### 2.1.3.8. Railways Operation and Management

The development of railway transportation in Japan through high-speed train operations in 1964 is significant. Railway transportation is less utilized compared to road transportation. However, regardless of the amount of investment made in road transportation, it has not reached the expected level in terms of safety, traffic accidents, environmental damage, and energy consumption. With the recent advancements in technology, railway investments have been given priority in AUS action plans [11]. Systems used in railway operation and management include Automatic Train Stop System, Train Control System, Train Control Computer, Speed Detection System, Level Crossing Monitoring System, Train Information System and Control Centre, Automatic Train Operation System - Driverless Train Operation System, and Train Monitoring and Information System [12].

## 2.2. Disadvantaged Groups

According to the United Nations Educational, Scientific and Cultural Organization (UNESCO), disadvantaged groups are defined as "individuals who, due to their economic status, gender, ethnic or linguistic origin, religion, or (for example, refugees) political status, have lower chances of social and economic integration compared to other people." These are individuals who do not own land or other income-generating assets and are often deprived of basic social necessities such as health, housing, and education [61]. While the scope of disadvantaged groups may vary from country to country, in our country, they are mostly considered to be the unemployed, the poor, the uneducated, women, those without social security, the homeless, socially discriminated groups, addicts, the disabled, children, and the elderly [62]

According to Mayer [63], disadvantaged groups are groups of workers who, in the context of the labor economy, have lower adaptability during the process of starting and continuing work. Groups such as the disabled, women, youth, long-term unemployed, and immigrants experience more difficulties in finding employment and working compared to the majority of the population. When we look at the society in terms of education, health, information and social relations, it is seen that disadvantaged groups cannot access or have difficulties in accessing the opportunities they have in general [63]. Addressing the disadvantaged groups in the labor market Barrett [64], grouped them as people over 50, ethnic minorities, people with disabilities, single parents, the needy poor and people with low quality [64].

The general definition of disadvantaged groups is often related to the issue of social exclusion. Thus, the unemployed and low-income earners, those who have been ill or disabled for a long time, elderly individuals, ethnic minorities, single parents, and those living in remote rural areas constitute disadvantaged groups [65]. According to Caillods [66], they are defined as groups that face difficulties in taking their place in society economically and socially due to their gender, economic status, religion, race, ethnic and linguistic origins, and political situations[66].

ITS The Ministry of Family, Labor and Social Services includes the strategic action plan to identify the needs that are important for increasing the comfort and mobility of people with disabilities and people with reduced mobility, and the institutions that will meet these needs. The action is planned to be carried out in cooperation with the Ministry of Transportation and Infrastructure, the Ministry of Health, the Ministry of Interior, the KVKK, NGOs, the Union of Turkish Bar Associations, and municipalities. In the first application step, a document will be prepared within the scope of ITS that identifies the needs and proposed solutions for those with mobility limitations. The aim of this application is to determine what ITS solutions and needs can facilitate the lives of individuals with mobility limitations, and to identify which institutions will meet these solutions. In the second application step, a document will be prepared within the scope of ITS for projects and responsible organizations related to individuals with mobility limitations, which will be shared with relevant organizations. The aim of this application is to create a report by identifying the necessary projects and responsible organizations within the scope of the prepared document, and sharing them with the institutions/organizations [17]

Between 2013 and 2023, the Turkish population increased by 11.4%, from 51.8 million to 57.7 million. This has led to a high proportion of elderly individuals in the country. In 2012, the elderly population (65 years and older) was 5.7 million, accounting for 7.5% of the population. According to projections, the elderly population is expected to reach 8.6 million in 2023, accounting for 10.2% of the population, 19.5 million in 2050, accounting for 20.8% of the population, and 24.7 million in 2075, accounting for 27.7% of the population [67].

It is estimated that 15% of the world's population has some type of disability, and these individuals experience significant difficulties in normal functionality at a rate of 2-4% [68]. According to the 2011 Turkish Population and Housing Census (PHC), a type of disability such as physical, hearing, vision, positioning, or memory was observed in people aged 3 and over. This accounts for approximately 6.9% of individuals with disabilities, which is higher than other disabled individuals. Therefore, the proportion of individuals aged 3 and over who experience difficulty in walking and climbing stairs is 6.7%, while the proportion of those who do not experience difficulty is 90% [69]. Additionally, 12.9% of individuals with disabilities have reported that public transportation is not suitable for their environment [69].

As stated in the study by Özispa and Arabelen [70] the challenges faced by disabled individuals in public transportation include obtaining information, accessing the transportation vehicle, waiting for the transportation vehicle, moving towards the destination, boarding and disembarking the transportation vehicle, and traveling within the vehicle. Firstly, in terms of obtaining information, the lack of smart travel information systems or systems not designed for disabled individuals, as well as insufficient signage and audio information services in stations/stops/terminals, lead to stress caused by information gaps during the journey planning stage. Secondly, in terms of accessing the transportation vehicle and moving towards the destination, difficulties in reaching stations/stops/terminals and inadequate transfer options are the main issues. Thirdly, boarding and disembarking the transportation vehicle require the use of vehicles at the stops, stations, etc. and the need for access ramps during boarding and disembarking. Fourthly, during travel within the transportation vehicle, challenges include the lack of access to upper decks on some ferries, the absence of disabled toilets on ferries, inadequate signage and audio information services within the vehicles, and the absence of wheelchair locking equipment within the vehicles. Strategies developed to address the challenges faced by disabled individuals have not yielded short-term solutions in any country [70].

In a study conducted by Ercoli, Ratti and Ergül [71] in İzmir, the difficulties experienced by users during the services of İzdeniz, which provides public transportation services, were examined. According to this study, the main difficulties faced by mobility-impaired passengers during İzdeniz voyages were the need for assistance from staff during boarding and disembarking, the absence of disabled toilets on ferries, and the absence of a mechanism for passengers to access the upper deck on ferries. Visually and hearing-impaired passengers reported insufficient audio information and signage services both on ferries and at terminals [71].

In the European Disability Strategy report published by the European Commission in 2010, the necessity of legislation and standardization efforts was emphasized to create suitable environments through digital agenda and innovative technologies for eliminating the challenges faced by disabled individuals in transportation and increasing accessibility and communication technologies. The recommended strategies for improving the accessibility of disabled individuals in the report include the aforementioned issues. In the strategies proposed in the report to increase the accessibility of people with disabilities,

- Conscious use of EU funds allocated for the purpose of accessibility and prevention of discrimination,
- Increasing the visibility and awareness of funding opportunities provided through various EU projects,
- Raising awareness levels of both people with disabilities and the public about the rights of disabled individuals and how to exercise these rights,
- Promoting and supporting the comprehensive identification and statistical collection of existing problems related to disabled individuals [72].

Waara [73] conducted a survey study on a travel information system designed for elderly and disabled individuals in four different cities with four different transportation infrastructures in Sweden. As a result of this study, it has been observed that the need for the travel information system has increased according to the disability rates of the disabled individuals. It has been stated that the reason for this is that different transportation systems are needed for different types of obstacles, that it is important to work on public transportation information systems regionally and to create the most appropriate relevance of the transportation system [73]. In addition, another study conducted by Waara [74] indicated that the stress experienced by disabled individuals during the information stage of travel planning is an important issue. In the study, it was emphasized that the development of a new online information system that can be used in the public transportation process is a great factor in improving the transportation quality for both disabled individuals and other citizens living in the country [74].

In a study conducted by Bezyak, Sabella and Gattis [75] with disabled individuals using public transportation vehicles in America, the inadequacy of transfer opportunities was stated as the most important variable hindering their mobility. In this study, station/terminal accessibility difficulties, the education, knowledge or attitudes of transportation vehicle or station staff, and gaps or steps at transportation vehicle entrances were listed as the problems that disabled individuals face in accessibility and transportation. This study is important in identifying areas that need improvement by revealing the areas that hinder disabled individuals' accessibility [75].

Hakverdi [10] addresses the problems encountered by disabled individuals when using public transportation in their study. In fact, these problems are also encountered by the elderly and pregnant individuals. These problems.

- Not arriving on time at bus stops,
- Unidentifiable bus stops for disabled individuals,
- Overcrowding of public transportation during rush hours,
- Disabled individuals being unable to benefit from transportation due to the participation of vehicles without machine equipment systems designed for them,
- Disabled individuals being unable to find the support they require from personnel on public transportation [10].

Suen et al. (1998) developed some of the problems faced by the passengers traveling in public transportation and suggested solutions for these problems.

Table 3. Some Problems that Passengers Experience in Public Transport and Suggestions for Solutions (Source: Suen, Mitchell and Henderson [76])

| **Problems** | **ITS Element** |
|---|---|
| Hearing impairment | Induction loop in buses |
| Defect of vision | talking devices |
| Unable to read next bus lines due to vision problem | Voice notification of incoming bus number at stops |
| Inability to identify destination due to vision problem | Screens showing the next stop on public transport |
| Insufficient or lost cash | smart cards |
| Do not miss the time of the next bus due to vision problems | Devices and applications that connect passengers and buses |
| Waiting for the bus in cold weather | Devices that show how long the bus will arrive at home or at the stop |

Hakverdi [10] has developed an application called "Accessible Smart Transportation in Smart Cities" using NFC cards and IoT technology. With this application, disabled individuals can scan their NFC card at the bus stop to inform the transportation coordination unit of their desired bus route number. Based on this information, the responsible individuals dispatch the necessary transportation vehicle for the disabled individuals. This application has solved transportation problems for disabled individuals [10].

WeWALK smart cane, developed for visually impaired individuals, is a product designed to provide solutions to daily problems. The smart cane connects to the WeWALK mobile application via Bluetooth and warns users of obstacles detected by sensors along their route with vibrations. Smart canes connect wirelessly to smartphones [77].

Another smart technology developed for visually impaired individuals is the Horus smart vision system, which detects what users want to see and provides audio information accordingly. This device can be considered as a personal assistant for disabled individuals in their daily lives, as it has many technical features such as text reading, motion and location information, object detection, scene and photo interpretation, and facial and people recognition [78].

## 2.3. Transportation Disadvantaged

There is no general definition of disadvantage in transportation in the literature. In one study, it was found that the 'transportation disadvantaged' (TDA) group consists mainly of people with disabilities, young people, elderly people, low-income individuals, and those who do not have or have limited access to special transportation [79]. In another study, 'Transportation Disadvantaged' (DA) populations are defined as individuals who personally have difficulty or are unable to transport themselves, or who are unable to purchase transportation due to physical or mental disabilities, income status, age, etc. [80]. Additionally, the concept of transportation disadvantage is generally considered in relation to social exclusion in the literature. Social exclusion focuses on barriers that make it difficult for people to participate in society and defines those who are deprived of economic, social, and political activities as excluded. Transportation is one of the main reasons for social exclusion due to its connection to people's access to activities [81]. Mobility and accessibility are the most important indicators of transportation's contribution to the social exclusion process [80]. Another study also states that better mobility and accessibility play a crucial role in people's inclusion in society through transportation [82]. Furthermore, transportation disadvantaged groups are considered to be the most vulnerable individuals among elderly and disabled individuals [83].

It has been observed that transportation disadvantaged groups are more prevalent in areas where there are access problems to public transportation. Therefore, access to transportation is directly linked to transportation disadvantaged individuals. Individuals who have access problems to public transportation are forced to use private vehicles, which results in higher transportation costs for them [84].

Disadvantaged groups in transportation are individuals who do not receive adequate services in terms of accessibility, mobility, cost, convenience, and access to information. The common characteristics of disadvantaged groups in transportation are extensively discussed in the literature-(see Duvarci, Yigitcanlar, Alver and Mizokami [85], Duvarci and Yigitcanlar [79], Lucas [86],Duvarci, Yigitcanlar and Mizokami [84])

# CHAPTER 3

# MATERIALS AND METHODS

## 3.1. Study Area

The province of Izmir, which has a surface area of 11,891 km2, is the largest province in the Aegean region and an important transportation hub, with a population of 4,425,763 as of 2022. The public transportation options in Izmir include the metro, tram, izban, and ESHOT buses. According to the 2011 Population and Housing Census [69], there were 206,142 people in Izmir with at least one type of disability, accounting for 9.6% of the population [87]. According to TUIK data, in 2021, 12.14% of the population in Izmir was elderly. Izmir is a key centre on the highways in the Aegean region, serving as the hub of the highways and connected to the European highway network. In Izmir, there are two main bus transportation services, ESHOT and IZULAS, which are affiliated with the Izmir Metropolitan Municipality. Buses serve all regions of Izmir but are more concentrated in the centre. It is home to one of the oldest railways in Anatolia, with the Alsancak Train Station under the responsibility of TCDD 3rd Regional Directorate. IZBAN is a suburban train system in Izmir, serving on 3 lines, the Central Line between Cumaovasi-Menemen, the South Line between Selcuk-Cumaovasi, and the North Line between Menemen-Aliağa. The Izmir Metro is the rapid transit system in Izmir, which serves from Fahrettin Altay to Evka 3. Projects are underway to expand the metro line. Additionally, the tramway is one of the public transportation options in Izmir, serving on two lines: T1 (Karşıyaka tram) and T2 (Konak tram).

As seen in the figure, districts that benefit from transportation vehicles are Narlıdere, Karabağlar, Balçova, Konak, Buca, Gaziemir, Bornova, Bayraklı, Karşıyaka, and Çiğli.

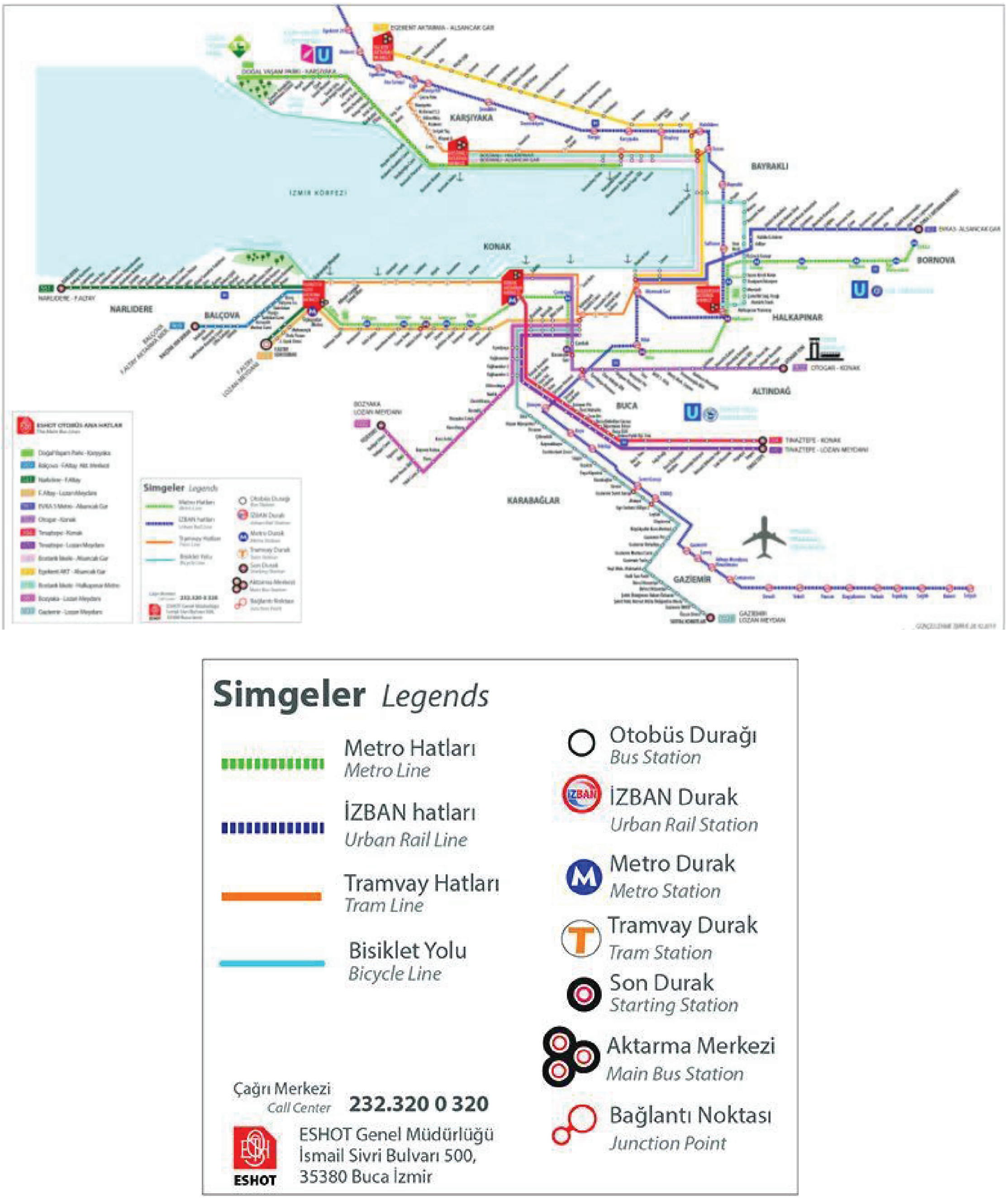


Figure 7. Izmir Transportation Network Map
(Source: TransportationMap [88])

## 3.2. Scope of the Study

The study was conducted in a region determined based on the areas where applications are concentrated, and urban mobility is highest among Izmir transportation vehicles. Research was conducted and data was collected on the experiences of all individuals except those aged 0-13 who benefit from urban transportation vehicles and individuals over the age of 65 who cannot stand up. In this study, a survey was conducted for disabled and elderly individuals within the disadvantaged groups category. Thus, the effects of Intelligent Transportation applications on disadvantaged individuals and other individuals were compared, contributing to the literature.

The study largely covers researching the ability of disabled, elderly, and other individuals benefiting from transportation vehicles to benefit from Intelligent Transportation Systems applications and the problems they face. Based on the data obtained from the survey conducted on these individuals, the aim is to determine the effects of Intelligent Transportation Systems applications on disadvantaged and transportation-disadvantaged individuals living in the city, and to develop recommendations regarding these applications.

## 3.3. Hypotheses of the Study

Hypothesis 1:

H0: There is a significant difference in people's awareness of intelligent transportation system applications.

H1: There is no significant difference in people's awareness of intelligent transportation system applications.

Hypothesis 2:

H0: There is a significant difference in people's satisfaction levels with intelligent transportation system applications among groups.

H1: There is no significant difference in people's satisfaction levels with intelligent transportation system applications among groups.

Hypothesis 3:

H0: There is a significant difference in people's knowledge and use of intelligent transportation system mobile applications.

H1: There is no significant difference in people's knowledge and use of intelligent transportation system mobile applications.

Hypothesis 4:

H0: There is a significant difference in people's knowledge and use of intelligent transportation system applications while traveling.

H1: There is no significant difference in people's knowledge and use of intelligent transportation system applications while traveling.

Hypothesis 5:

H0: There is a significant difference in people's knowledge and use of intelligent transportation system applications while using public transportation.

H1: There is no significant difference in people's knowledge and use of intelligent transportation system applications while using public transportation.

Hypothesis 6:

H0: There is a significant difference in people's usage levels of intelligent transportation system applications throughout the day among groups.

H1: There is no significant difference in people's usage levels of intelligent transportation system applications throughout the day among groups.

Hypothesis 7:

H0: There is a significant difference in people's ability to access their daily tasks in a timely manner by using intelligent transportation system applications among groups.

H1: There is no significant difference in people's ability to access their daily tasks in a timely manner by using intelligent transportation system applications among groups.

Hypothesis 8:

H0: There is a significant difference in people's comfort level during travels with the use of intelligent transportation system applications among groups.

H1: There is no significant difference in people's comfort level during travels with the use of intelligent transportation system applications among groups.

Hypothesis 9:

H0: There is a significant difference in people's perception of the economic impact of intelligent transportation system applications among groups.

H1: There is no significant difference in people's perception of the economic impact of intelligent transportation system applications among groups.

Hypothesis 1:

H0: There is no significant difference between groups regarding the economic (financial) impact of ITS applications on individuals.

H1: There is no significant difference between groups regarding the economic (financial) impact of ITS applications on individuals.

Hypothesis 10:

H0: There is a significant difference between groups regarding the positive contribution of ITS applications to daily life.

H1: There is no significant difference between groups regarding the positive contribution of ITS applications to daily life.

Hypothesis 11:

H0: There is a significant difference between groups regarding encountering problems while using ITS applications.

H1: There is no significant difference between groups regarding encountering problems while using ITS applications.

## 3.4. Method

The data to be used in the study were obtained by the survey method. For the study, a face-to-face survey was conducted with individuals in the household with closed and open-ended questions. First of all, systematic random sampling method was used in the selection of households to be interviewed. Secondly, category analysis was performed on the collected data and individuals were divided into three groups. Thirdly, the Statistical Package for Social Sciences (SPSS) was used to analyse the data.

Table 4. Elderly Population Rates in Central Districts of Izmir

| | Total population | Over 65 years old | Elderly Population Ratio |
|---|---|---|---|
| Bornova | 452867 | 44966 | 10,07 |
| Balçova | 80513 | 12554 | 6,41 |
| Karşıyaka | 347023 | 55923 | 6,21 |
| Buca | 517957 | 47494 | 10,91 |
| Konak | 336544 | 53615 | 6,28 |
| Bayraklı | 278571 | 31322 | 8,89 |
| Narlıdere | 63438 | 10030 | 6,32 |
| Karabağlar | 478788 | 55064 | 8,70 |
| Gaziemir | 137856 | 12226 | 11,28 |

The study is to conduct a survey study in selected neighbourhoods, considering the areas where the elderly population is high, transportation systems are concentrated, and urban mobility is the highest. The site selection criteria in the study area were examined in 2 stages: District and neighbourhood levels. At the district level, firstly, the proportion of the elderly population was examined. As can be seen in Table 1, when the elderly population ratios are examined in the central districts of İzmir, the districts with the highest rates are Gaziemir, Buca and Bornova. Secondly, transportation systems are examined. Gaziemir and Buca districts are not selected because there is not enough transportation system. It was chosen because there is an adequate transportation system in Bornova district. Then, Karabağlar and Konak districts were selected among the districts with a high proportion of elderly population and high transportation systems.

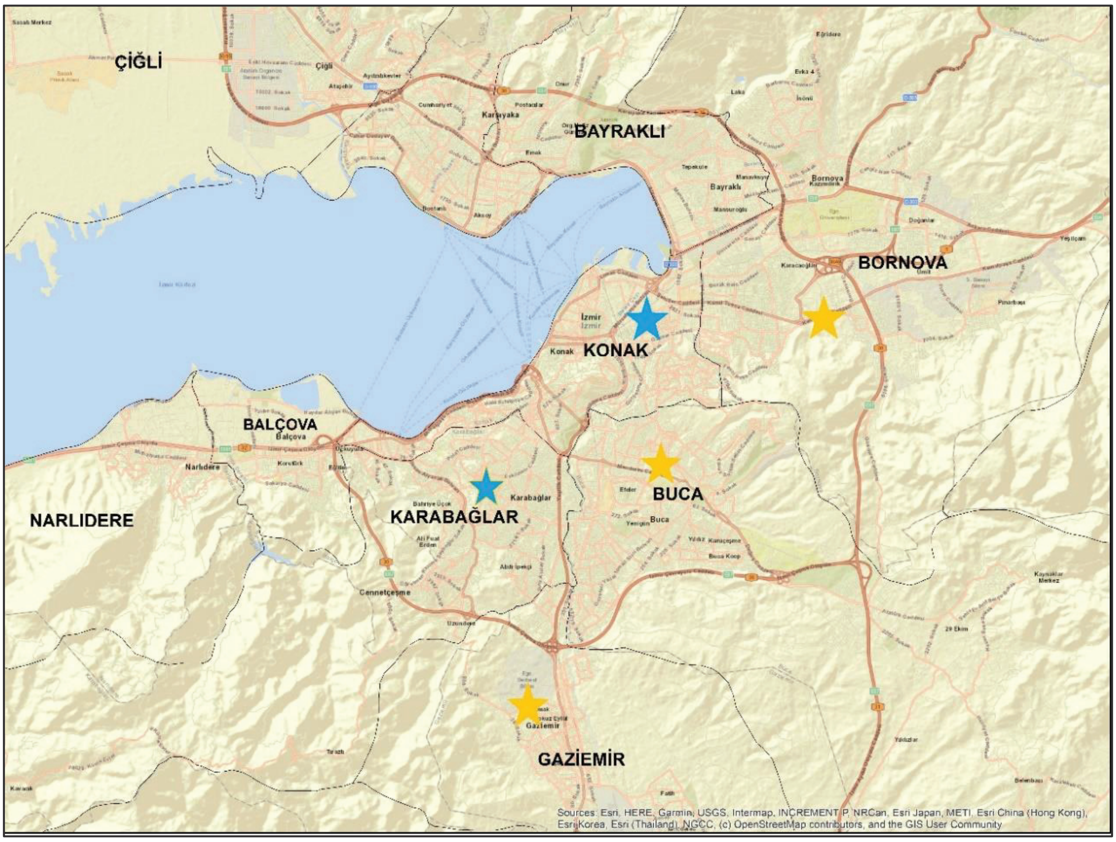


Figure 8. Districts with the Highest Elderly Population Rates

Neighbourhood settlement first includes population sizes. The view of neighbourhoods with a population of 5,000 to 10,000 among the selected districts. Second, it shows neighbourhoods where it shows transportation items. Accordingly, the study was carried out in Fahrettin Altay neighbourhood in Karabağlar District, Yıldırım Beyazıt neighbourhood in Bornova county, and Mimar Sinan neighbourhood in Konak county.

The studies were carried out with the participation of 910 people for approximately 30 days in the relevant neighbourhoods after the necessary permissions were obtained from the IZTECH Social and Human Sciences Scientific Research and Publication Ethics Committee and the Izmir Police Department. The sampling rate of this survey study is 0.5 percent.

During the interviews, they were asked which transportation systems they use, how long it takes to get to their destination, which Intelligent Transportation System applications they use, the difficulties they face while using the applications, what suggestions they can make for the difficulties they face, whether they feel disadvantaged in transportation or not, and questions regarding the difficulties they face in transportation.

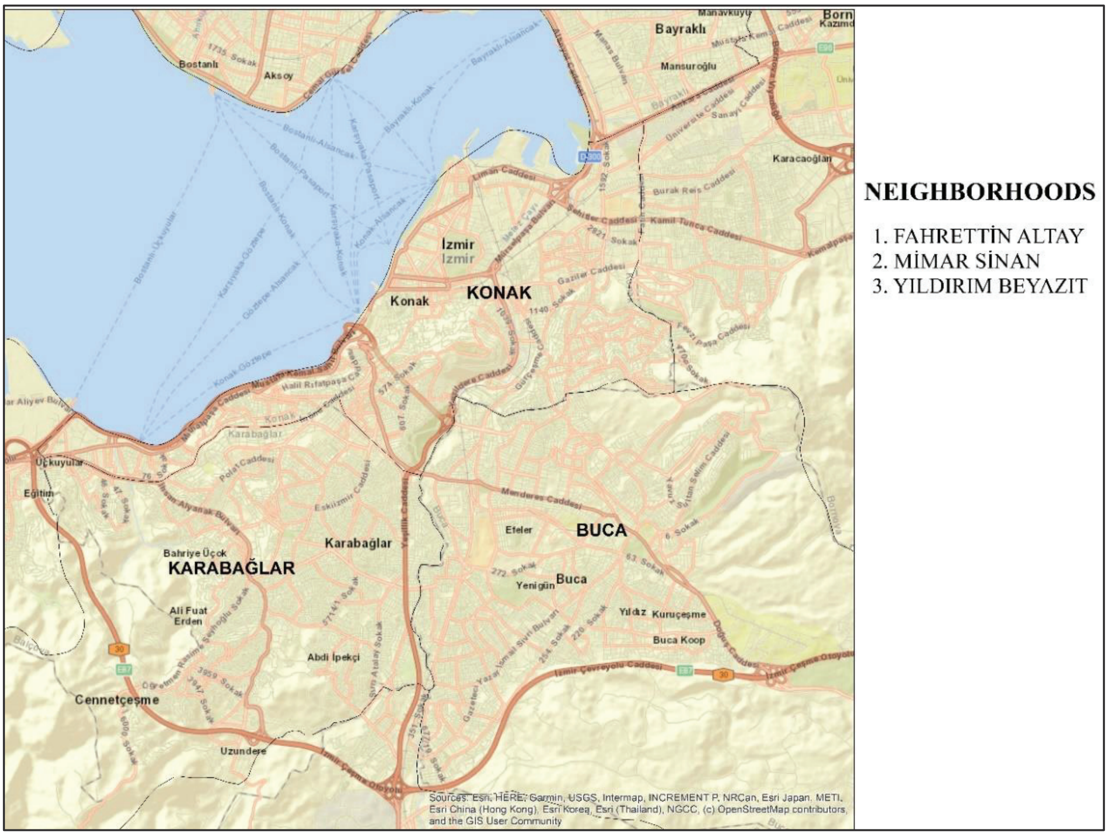


Figure 9. Locations of Selected Neighbourhoods on the Map

During the data analysis stage, Excel, and the Statistical Package for Social Sciences (SPSS) were used. Firstly, the surveys conducted by the participants were transferred to Excel and then data sets were prepared for SPSS. After the data sets were created, tables were generated based on the results.

In the study, first, descriptive statistics were made to measure how the distribution of the data obtained after the survey was conducted. Secondly, the data were divided into 3 groups by applying category analysis to the obtained data. The results on the basis of groups are presented in the analysis section. Third, the One-way ANOVA test was applied to measure whether there was a significant difference on the basis of groups.

As shown in Figure 2, three groups were considered: Disadvantaged individuals, Transportation Disadvantaged individuals, and non-Disadvantaged individuals. Disadvantaged groups consist of disabled and elderly individuals. Transportation

Disadvantaged groups consist of individuals who feel disadvantaged in transportation. Non-Disadvantaged groups consist of individuals who are not disabled or elderly. However, Transportation Disadvantaged individuals can encompass both Disadvantaged and Non-Disadvantaged groups. It includes all the collected data in total.

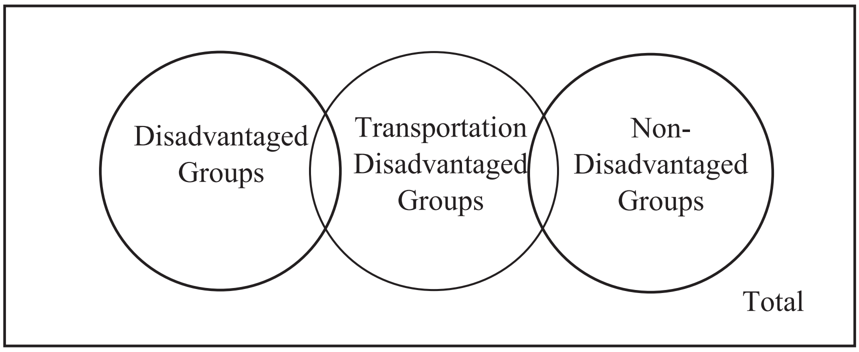


Figure 10. Distribution Chart of Individuals by Groups

# CHAPTER 4

# RESULT AND DISCUSSIONS

## 4.1. Descriptive Statistics

As can be seen in Table 5, an above-average result was obtained in knowing ITS applications in mean values. This shows that more than half of the individuals know ITS applications. Looking at the SD results, it is below the average value in knowing ITS applications, which shows us that the values close to the average are higher. In the transportation disadvantageous data, the average was found to be 0.16 and the SD 0.37. This shows us that the values far from the mean are a little too high.

Table 5. Results of Descriptive Statistics

| | Mentally Disabled | Visually impaired | Physical Disabilities | Hearing Impaired | Speech and Language Disabled | Other | Over 65 years old | Transportation Disadvantage | Knowing /Being Aware of ITS Applications |
|---|---|---|---|---|---|---|---|---|---|
| Mean | 0 | 0 | 0 | 0 | 0 | 0,01 | 0,2 | 0,16 | 0,88 |
| Median | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| SD | 0 | 0,033 | 0,066 | 0 | 0 | 0,081 | 0,4 | 0,37 | 0,322 |
| Variance | 0 | 0,001 | 0,004 | 0 | 0 | 0,007 | 0,16 | 0,137 | 0,104 |

As can be seen in Table 6, it has been revealed that the use of Map applications is high in mean values. Considering the SD value, a value below the average was observed. Accordingly, it shows that the values close to the mean are more.

Table 6. Continuation of Descriptive Statistics results

| | KGM Türkiye Trafik | İzmir BB Mobile | İZUM | Map applications | ESHOT Mobile | Bisim Mobile | Bizİzmir | Kent Kart Mobile | İzmir Tarih | Acil İzmir | Other |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Mean | 0,01 | 0,08 | 0,09 | 0,74 | 0,35 | 0,07 | 0,1 | 0,21 | 0 | 0,01 | 0,12 |
| Median | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SD | 0,081 | 0,27 | 0,291 | 0,437 | 0,477 | 0,258 | 0,294 | 0,408 | 0,066 | 0,07 | 0,32 |
| Variance | 0,007 | 0,073 | 0,085 | 0,191 | 0,227 | 0,066 | 0,087 | 0,167 | 0,004 | 0,01 | 0,102 |

As seen in Table 7, it was found that the mean values of HGS-OGS-KGS, Smart parking, Smart pedestrian crossing system, Smart stop, Variable Message Signs were high. Considering the SD values, a value below the average was observed. Accordingly, it shows that the values close to the mean are more.

Table 7. Continuation of Descriptive Statistics results

| | HGS_OGS_KGS | Smart Parking | Smart pedestrian crossing system | Moovit | Smart Stop | ESHOT Mobile/ Web Application | İzmir BB Mobile/ Web Application | İZUM | Variable Message Signs | Other |
|---|---|---|---|---|---|---|---|---|---|---|
| Mean | 0,83 | 0,61 | 0,92 | 0,07 | 0,91 | 0,33 | 0,07 | 0,06 | 0,9 | 0,01 |
| Median | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 |
| SD | 0,375 | 0,489 | 0,27 | 0,254 | 0,285 | 0,472 | 0,252 | 0,242 | 0,297 | 0,09 |
| Variance | 0,141 | 0,239 | 0,073 | 0,065 | 0,081 | 0,222 | 0,064 | 0,059 | 0,088 | 0,01 |

As can be seen in Table 8, it has been revealed that Smart pedestrian crossing system, Passenger Information System, Smart Stop, ESHOT, Kent Card usage is high in mean values. Considering the SD values, a value below the average was observed. Accordingly, it shows that the values close to the mean are more.

Table 8. Continuation of Descriptive Statistics results

| | Smart pedestrian crossing system | Passenger Information System | Moovit | Bizİzmir | Bisim | Smart Stop | ESHOT | İzmir BB Mobile | Kent Kart | Other |
|---|---|---|---|---|---|---|---|---|---|---|
| Mean | 0,92 | 0,91 | 0,06 | 0,07 | 0,08 | 0,91 | 0,77 | 0,05 | 0,95 | 0,05 |
| Median | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 |
| SD | 0,27 | 0,29 | 0,232 | 0,261 | 0,278 | 0,286 | 0,418 | 0,219 | 0,212 | 0,24 |
| Variance | 0,073 | 0,084 | 0,054 | 0,068 | 0,078 | 0,082 | 0,175 | 0,048 | 0,045 | 0,06 |

As seen in Table 9, the mean values are 3.05 in Satisfaction levels, 2.06 in usage levels, Ease of Access 2.68, Comfort of Travel 2.71, Economic (Material) Impact 2.1, Positive Contribution 2.7 high. turned out to be. Considering the SD values, a value below the average was observed. Accordingly, it shows that the values close to the mean are more.

Table 9. Continuation of Descriptive Statistics results

| | Degree of Satisfaction with ITS Applications | Frequency of Use of ITS Applications during the Day | Ease of Access Using AUS Applications | Comfort of Travel with AUS Applications | Economic (Material) Impact of ITS Applications | Positive Contribution of ITS Applications in Daily Life | Having Problems Using ITS Applications |
|---|---|---|---|---|---|---|---|
| Mean | 3,05 | 2,06 | 2,68 | 2,71 | 2,1 | 2,7 | 0,17 |
| Median | 3 | 2 | 3 | 3 | 3 | 3 | 0 |
| SD | 0,467 | 0,534 | 0,583 | 0,565 | 0,948 | 0,611 | 0,379 |
| Variance | 0,218 | 0,285 | 0,339 | 0,319 | 0,898 | 0,374 | 0,144 |

In the Degree of Satisfaction with ITS Applications values, the "Satisfied" level is the highest value.

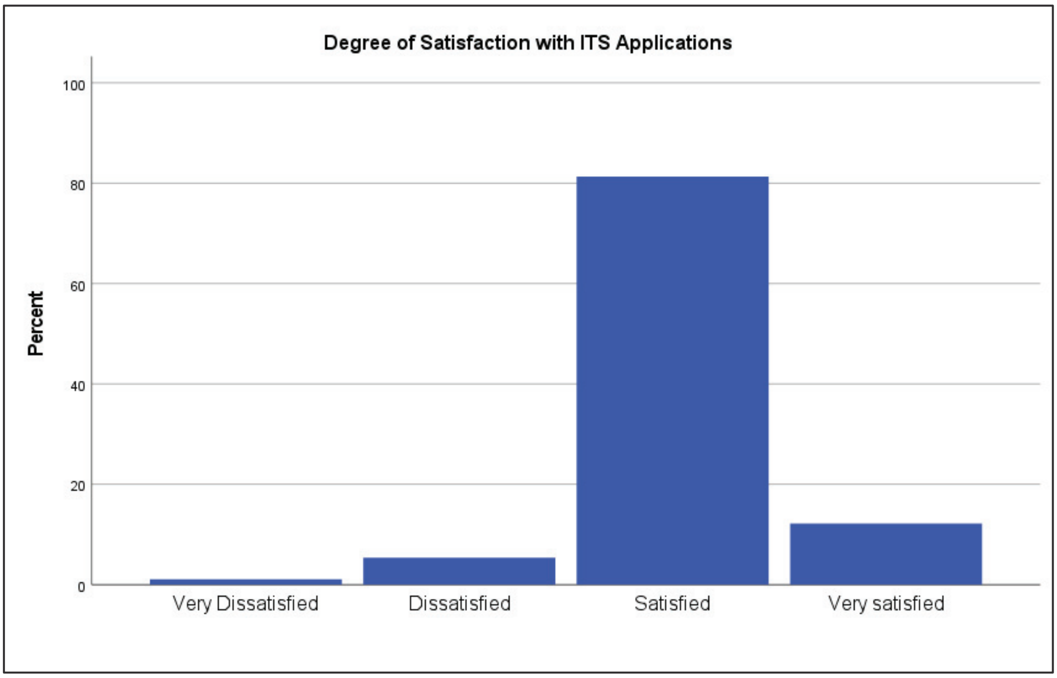

Figure 11. Distribution of Satisfaction Ratings with ITS Applications

In the Frequency of Use of ITS Applications during the Day values, the use of “1-2 times” is the highest value.

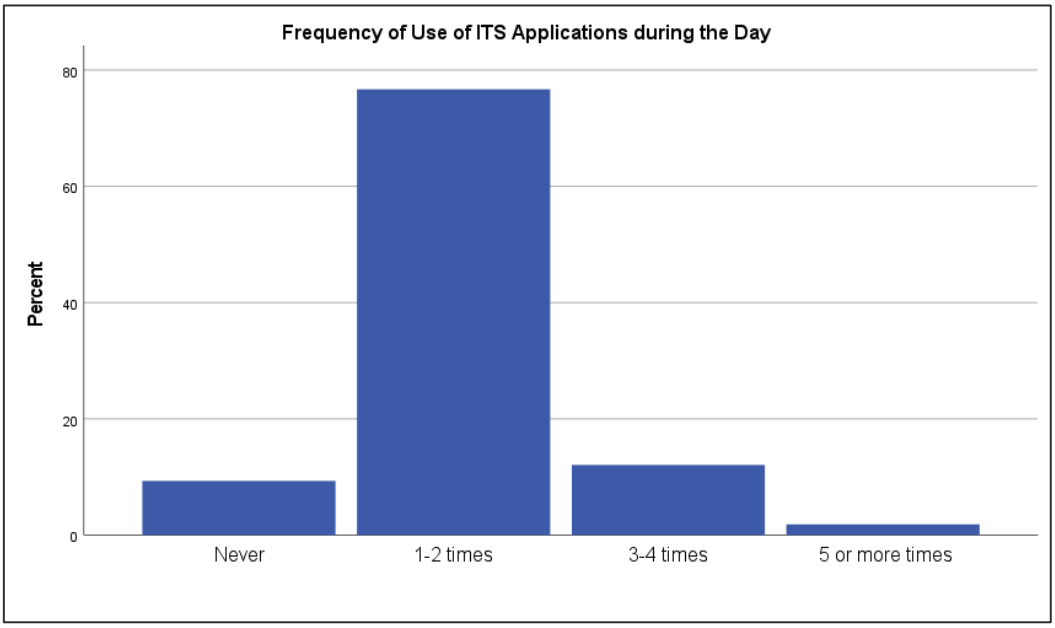

Figure 12. Intraday Frequency Distribution of ITS Applications

“Yes” value is the highest in Ease of Access Using AUS Applications values.

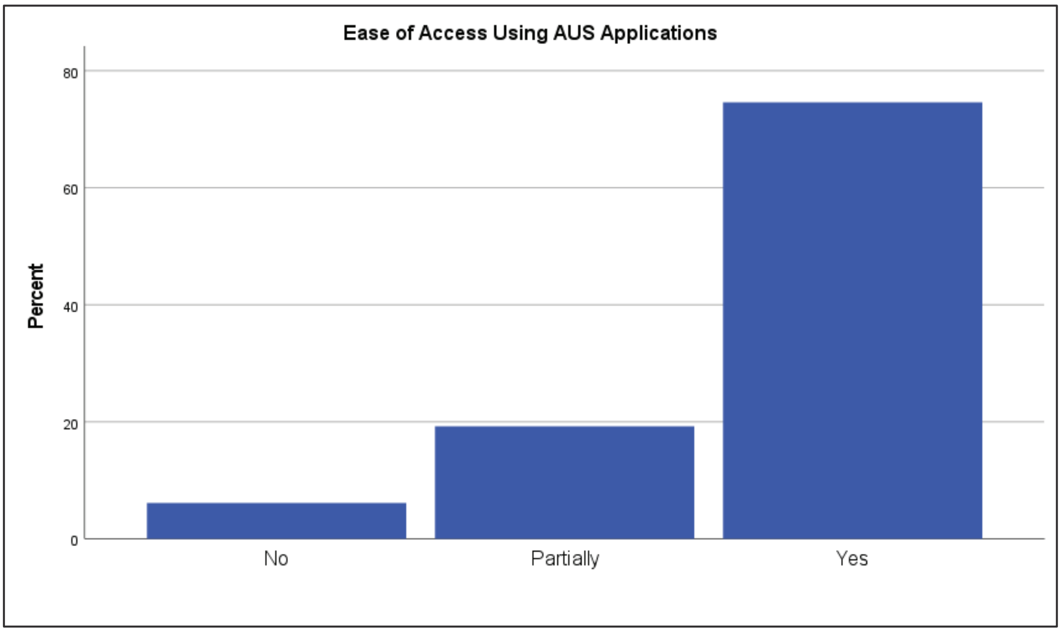

Figure 13. Ease of Access Distribution Using AUS Applications

"Yes" value is the highest in Comfort of Travel with AUS Applications values.

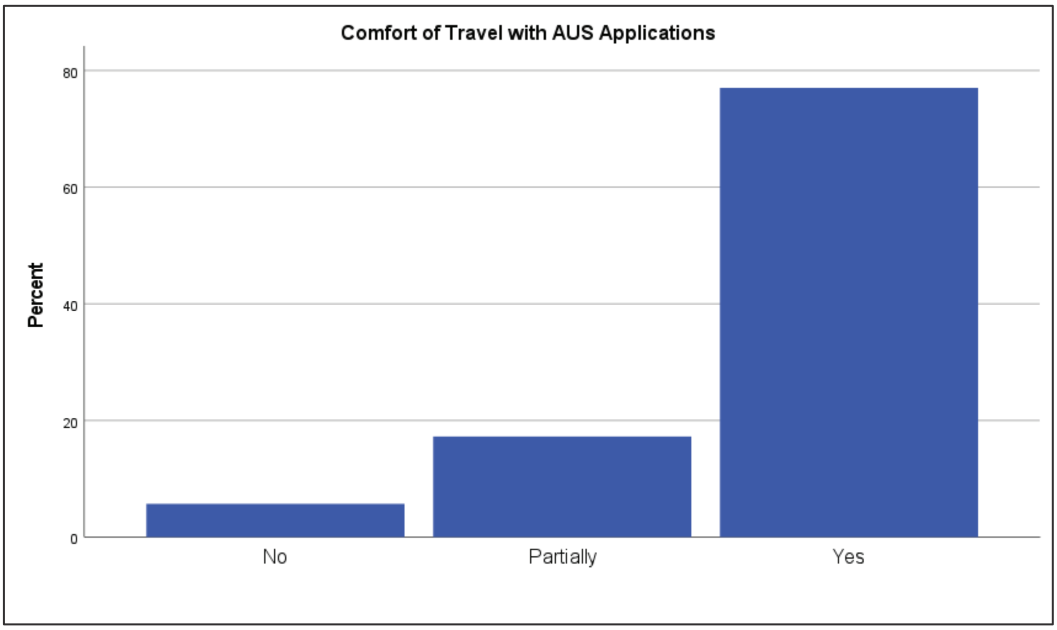

Figure 14. Distribution of Travel Comfort with ITS Applications

In the Economic (Material) Impact of ITS Applications values, "Yes" is seen at the rate of 50% and "No" at the rate of 40%.

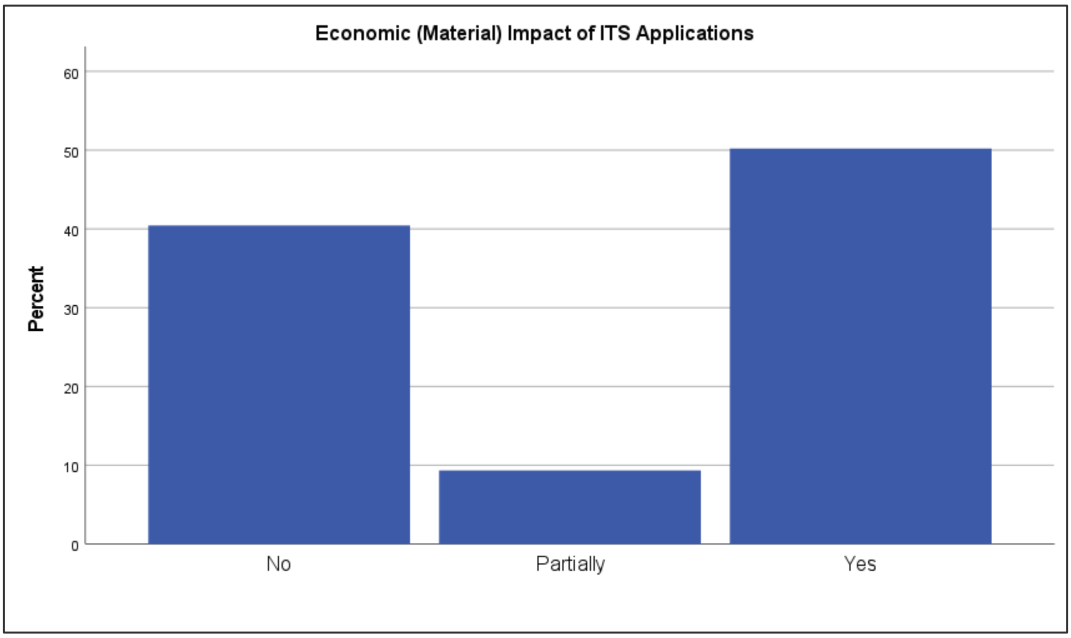

Figure 15. Distribution of Economic (Material) Impact of ITS Applications

“Yes” value is the highest in Positive Contribution of ITS Applications in Daily Life values.

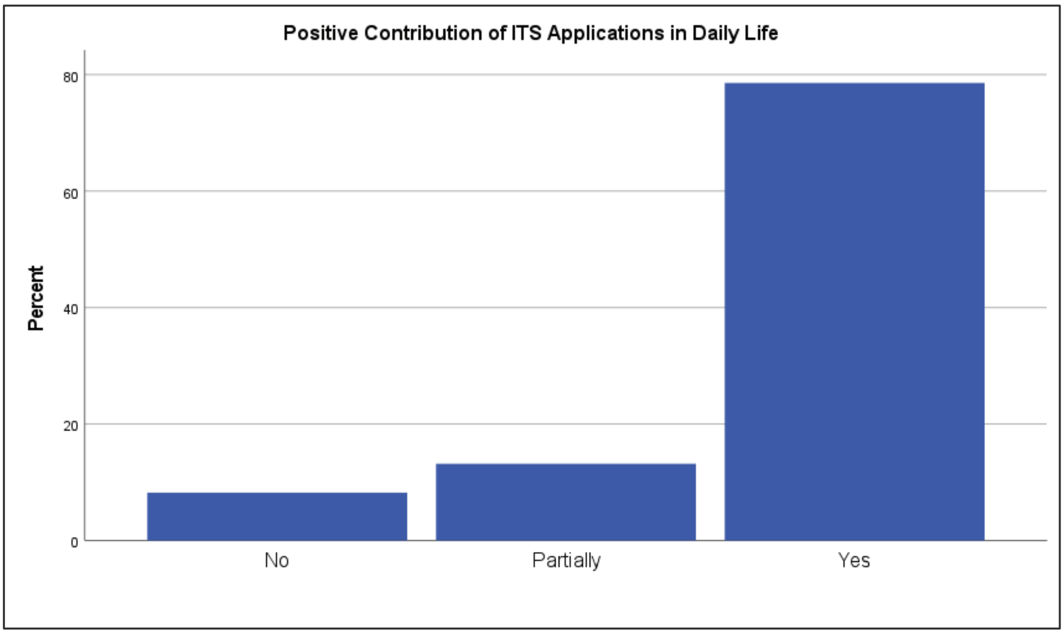

Figure 16. Distribution of Positive Contribution of ITS Applications to Daily Life

As seen in Table 10, it has been revealed that the use of Parking Nuisance, Traffic Jams, Lack of public transport is high in mean values. Considering the SD values, a value below the average was observed. Accordingly, it shows that the values close to the mean are more.

Table 10. Continuation of Descriptive Statistics results

| | Parking Nuisance | Air and sound pollution | Traffic Jams | Congestion of pedestrian and bicycle paths | Lack of public transport | The fact that public transport is of the old | Other |
|---|---|---|---|---|---|---|---|
| Mean | 0,55 | 0,34 | 0,85 | 0,39 | 0,49 | 0,27 | 0,04 |
| Median | 1 | 0 | 1 | 0 | 0 | 0 | 0 |
| SD | 0,497 | 0,473 | 0,36 | 0,488 | 0,5 | 0,443 | 0,203 |
| Variance | 0,247 | 0,224 | 0,13 | 0,238 | 0,25 | 0,196 | 0,041 |

## 4.2. Analyzes

### 4.2.1. Number of Vehicles in the Household

According to the total results obtained from analyzing all the data, the number of people who own one vehicle is the highest at 557 people, which corresponds to 61.2%, while the number of people who own three vehicles is the lowest at 8 people, which corresponds to 0.9%. 304 people, or 33.4%, have no vehicles in their households, while 41 people, or 4.5%, have two vehicles. As seen in Figure 1, among the groups, it is observed that 50% of transportation disadvantaged groups have one vehicle and 43% have no vehicles at all. Additionally, it is seen that 61% of disadvantaged groups have one vehicle, while 33% have no vehicles at all.

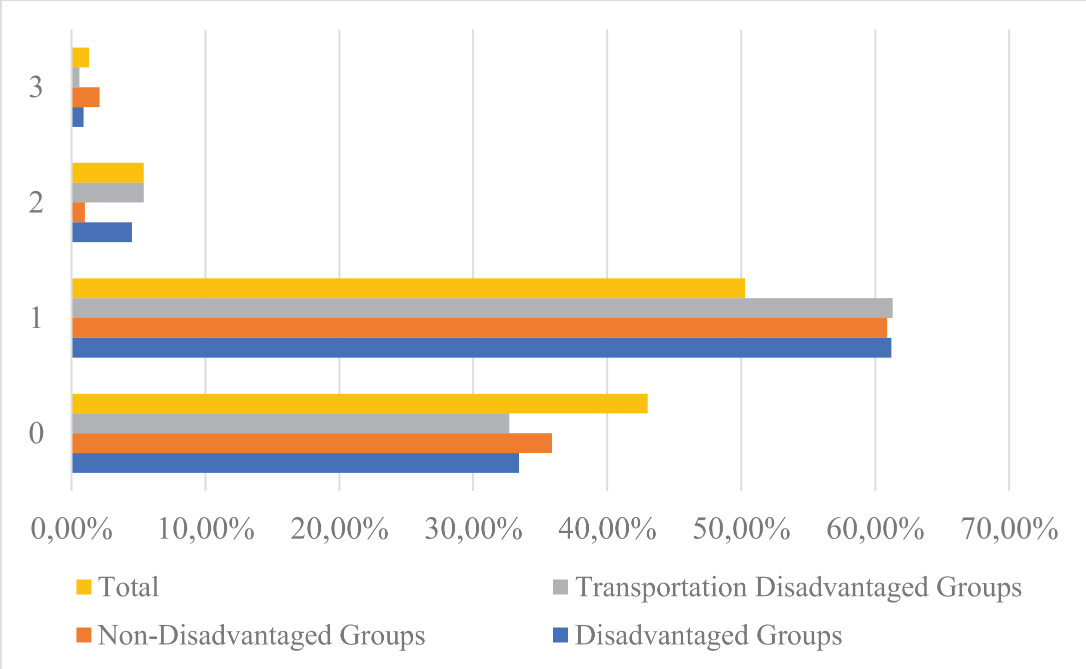


Figure 17. Distribution of the Number of Vehicles in the House by Groups

### 4.2.2. Disadvantage in the Household

Upon examining all the data, it was found that 290 individuals, or 32% of households, have disadvantaged status. In the entire dataset, 620 individuals, or 68% of households, do not have disadvantaged status.

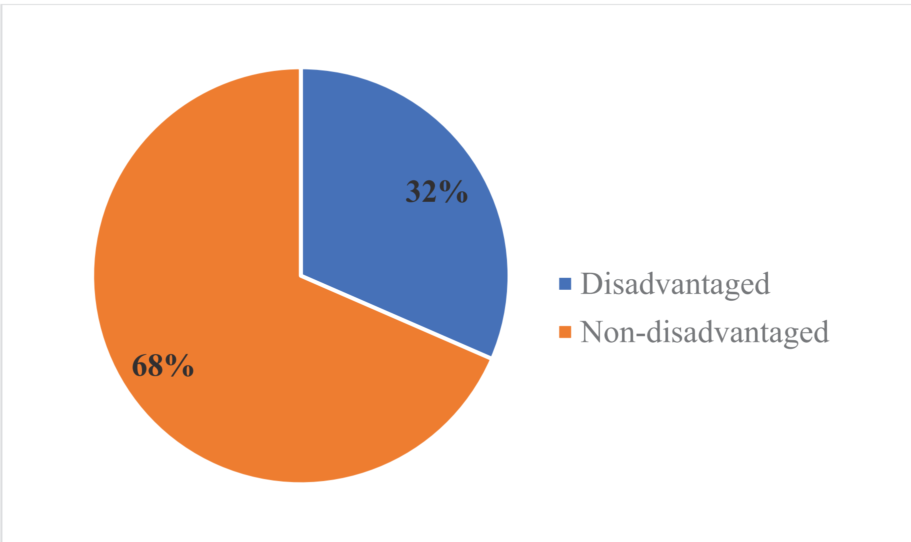


Figure 18. The Situation of disadvantage in the household

When examined by groups, the proportion of individuals with household disadvantage is 11% for transportation disadvantaged groups, 30% for those who are not disadvantaged but have household disadvantage, and 59% for those with household disadvantage in disadvantaged groups.

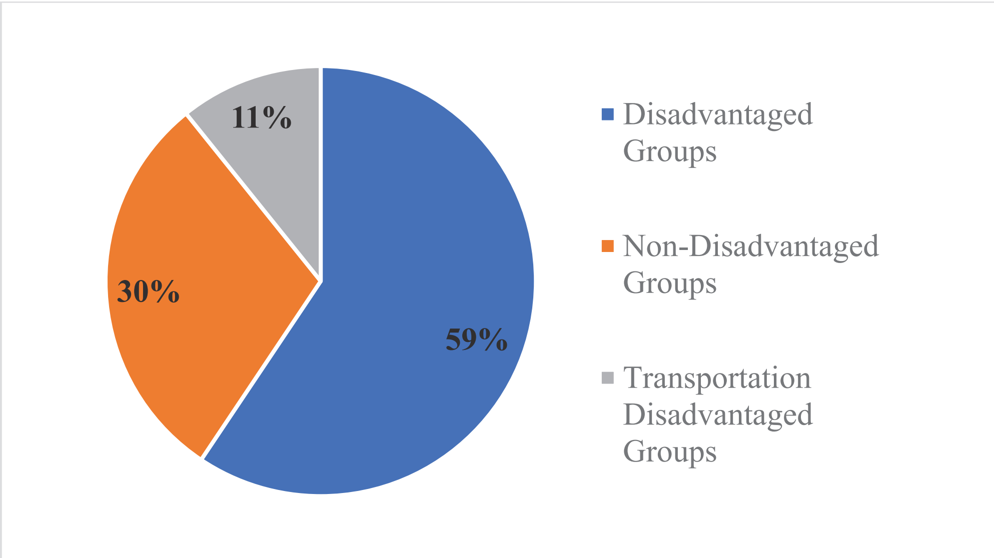


Figure 19.Disadvantageous situation in the household on the basis of groups

Of the 290 individuals with disadvantageous living conditions, 29 individuals or 10% are disabled, and 261 individuals or 90% are aged 65 and above. When examined by groups, disadvantaged groups have the highest percentage of individuals aged 65 and above, at 94%. Among individuals who are not disadvantaged but have disadvantageous living conditions, the highest percentage of individuals aged 65 and above is 81%. In transportation-disadvantaged groups, 85% of individuals are aged 65 and above.

According to the results, there are many individuals in non-disadvantaged groups who have disadvantaged individuals in their households, and it is seen that mostly elderly individuals are present. It has also been revealed that households with disabled individuals are more prevalent in transportation disadvantaged groups compared to other groups.

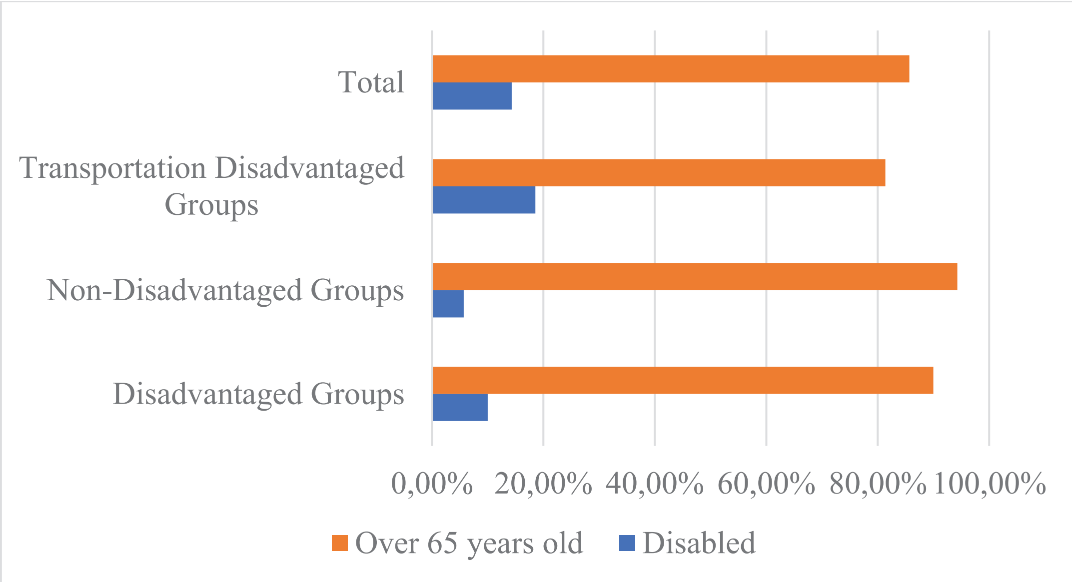


Figure 20. Disadvantage in the household on the basis of groups over 65 years old and disability

### 4.2.3. Disadvantage Status

When all the data is examined, it is found that 192 individuals, or 21%, have a disadvantaged status, while 718 individuals, or 79%, do not have a disadvantaged status among all the data.

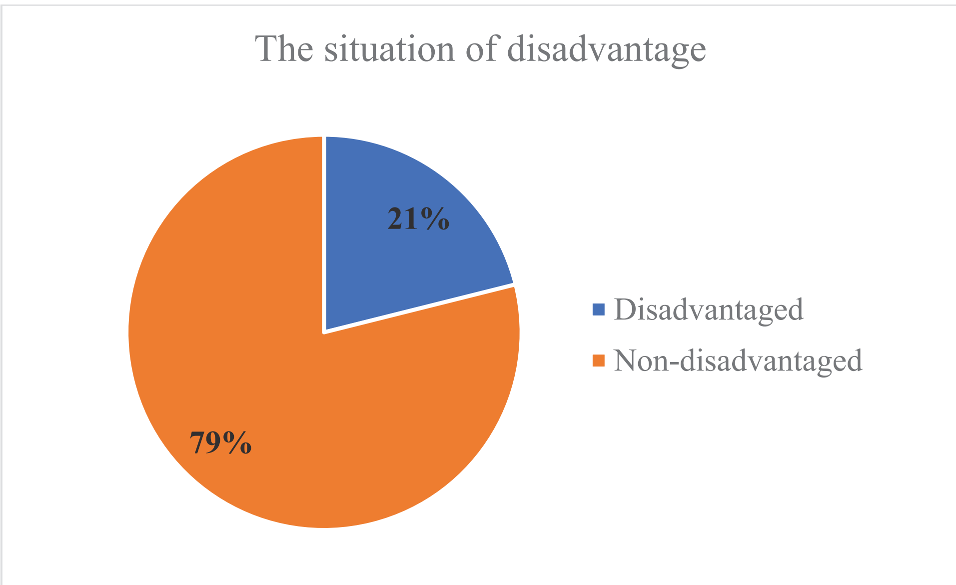


Figure 21. Disadvantage Distribution in Individuals

Among the individuals experiencing disadvantage, 1 person or 0.5% has visual impairment, 4 people or 2.1% have physical disabilities, 6 people or 3.1% have other types of disabilities, and 182 people or 94.3% are over 65 years old.

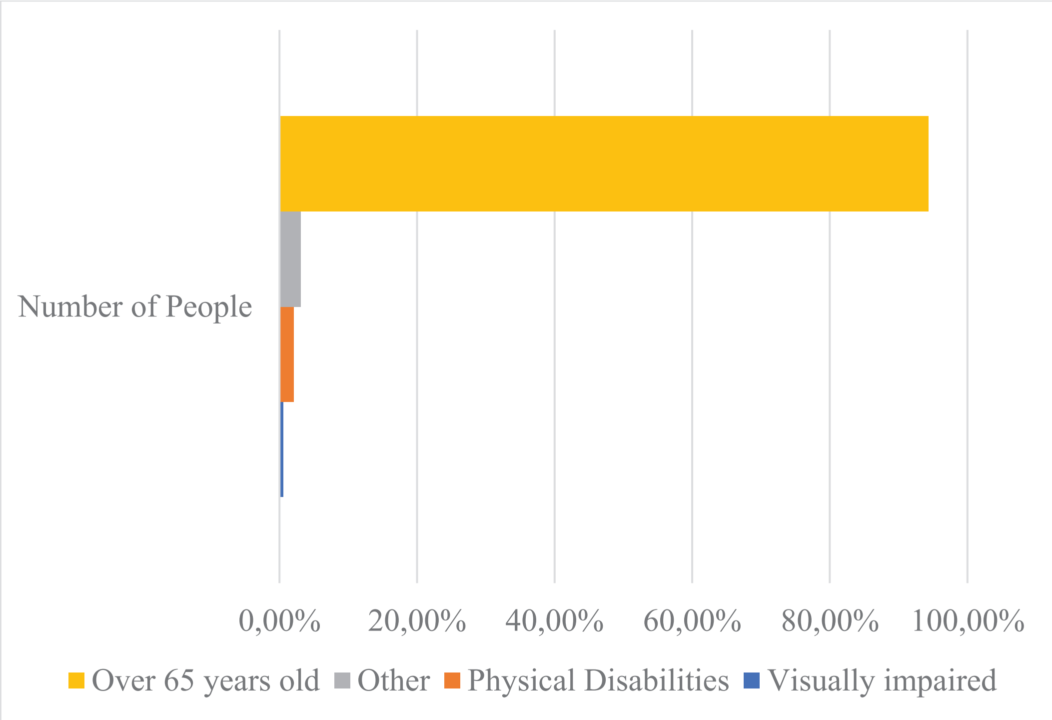


Figure 22. Disadvantages of Disadvantaged Individuals

According to the results, the highest labor force participation rate was observed among individuals aged 65 and over in disadvantaged groups.

### 4.2.4. Transportation Disadvantage

Transportation disadvantage refers to individuals who cannot access sufficient services in terms of accessibility, mobility, cost, convenience, and access to information. Accordingly, individuals who feel disadvantaged in terms of transportation have been considered in transportation-disadvantaged groups. When all data are examined, 761 people, or 84%, stated that they did not feel disadvantaged in transportation, while 149 people, or 16%, stated that they felt disadvantaged in transportation.

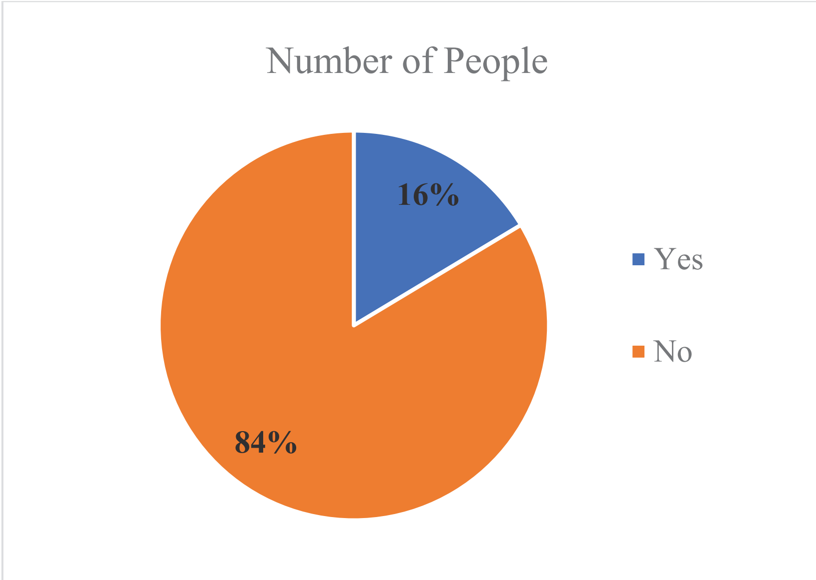


Figure 23. Distribution of Individuals Feeling Disadvantaged and Not Feeling Disadvantaged in Transportation

Among individuals who feel transportation-disadvantaged, 25 people or 17% of them are both disadvantaged and feel disadvantaged in transportation, while 124 people or 83% of them feel transportation-disadvantaged but are not disadvantaged otherwise.

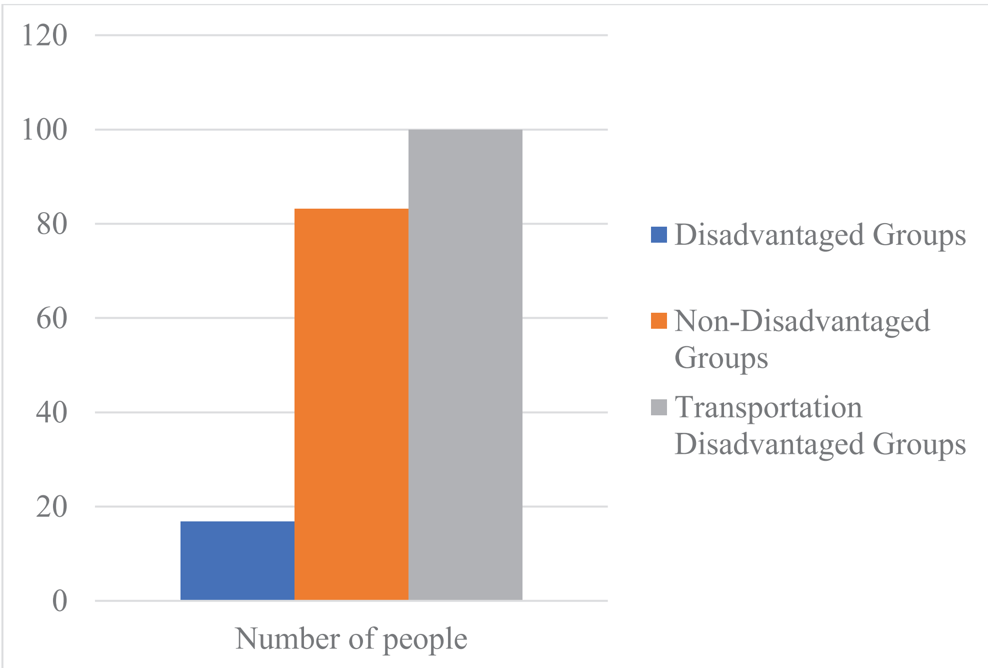


Figure 24.Distribution of Transportation Disadvantages by Groups

According to the results, there are individuals with disabilities who also feel disadvantaged in terms of transportation.

### 4.2.5. Transportation Systems Used in Journeys

Upon examining all the data, it can be seen that all individuals have used any of the 9 transportation methods available for their journeys within Izmir. Of the transportation methods used in their journeys, 910 individuals have made a total of 3,498 uses. Among the used transportation methods, disadvantaged groups have used a total of 635, transportation disadvantaged groups have used a total of 534, and non-disadvantaged groups have used a total of 2,863 transportation methods.

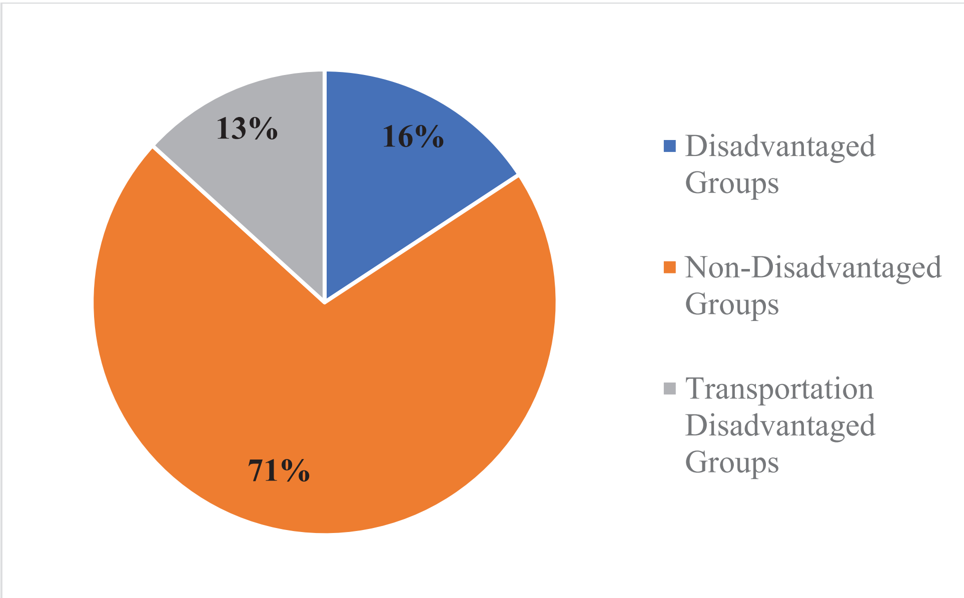


Figure 25. Distribution of Transportation Systems Used in Journeys

When the results are examined, it can be seen that the most preferred transportation methods in the trips made by individuals in Izmir are rail systems, buses, private vehicles, walking, and sea transportation. The least preferred system is motorcycles. Among the choices, 160 people or 25.20% of disadvantaged groups use rail systems the most in their trips. Then, 122 people or 23% are transportation disadvantaged groups and 631 people or 22% are non-disadvantaged groups. Among those who use buses the most in their trips, 147 people or 23% are disadvantaged groups. Then, 104 people or 19.50% are transportation disadvantaged groups and 533 people or 18.60% are non-disadvantaged groups. Among those who use private vehicles the most in their trips, 110 people or 17.30% are disadvantaged groups. Then, 14.10% are non-disadvantaged individuals and 13.30% are transportation disadvantaged groups. Among those who travel on foot the most, 71 people or 13.30% are transportation disadvantaged groups. Then, 13.20% are non-disadvantaged individuals and 10.60% are disadvantaged groups. Among those who use sea transportation the most in their trips, 329 people or 11.50% are non-disadvantaged groups. Then, 10.60% are disadvantaged groups and 9.90% are transportation disadvantaged groups. In addition, motorcycles are used the least in trips. 9 people or 1.70% of transportation disadvantaged groups use motorcycles the most. Then, 1.20% are non-disadvantaged groups and 0.50% are disadvantaged groups.

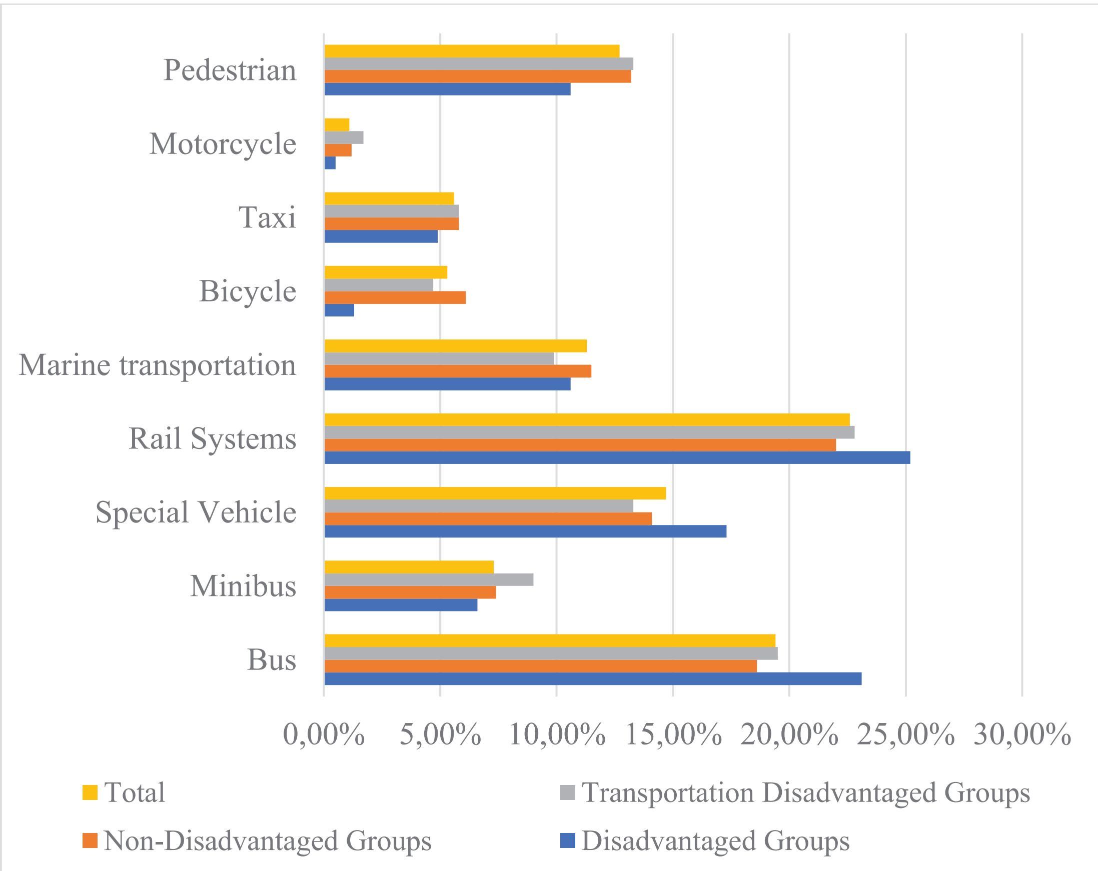


Figure 26.Distribution of Transportation Systems Used in Journeys by Groups

According to the results, disadvantaged groups use rail systems, buses, and private vehicles more than other groups. Transportation disadvantaged groups use pedestrian, minibus, and motorcycle more than other groups. Non-disadvantaged groups use sea transportation, bicycles, and taxis more than other groups.

### 4.2.6. Purpose of Journeys

Upon examining all the data, it can be observed that individuals in Izmir have chosen either one or more of the three purposes for their trips within the city. A total of 1,141 markings were made for the Travel Purposes of 910 individuals. As seen in the figure, disadvantaged groups made markings at a rate of 21%, non-disadvantaged groups at a rate of 66%, and transportation-disadvantaged groups at a rate of 13%.

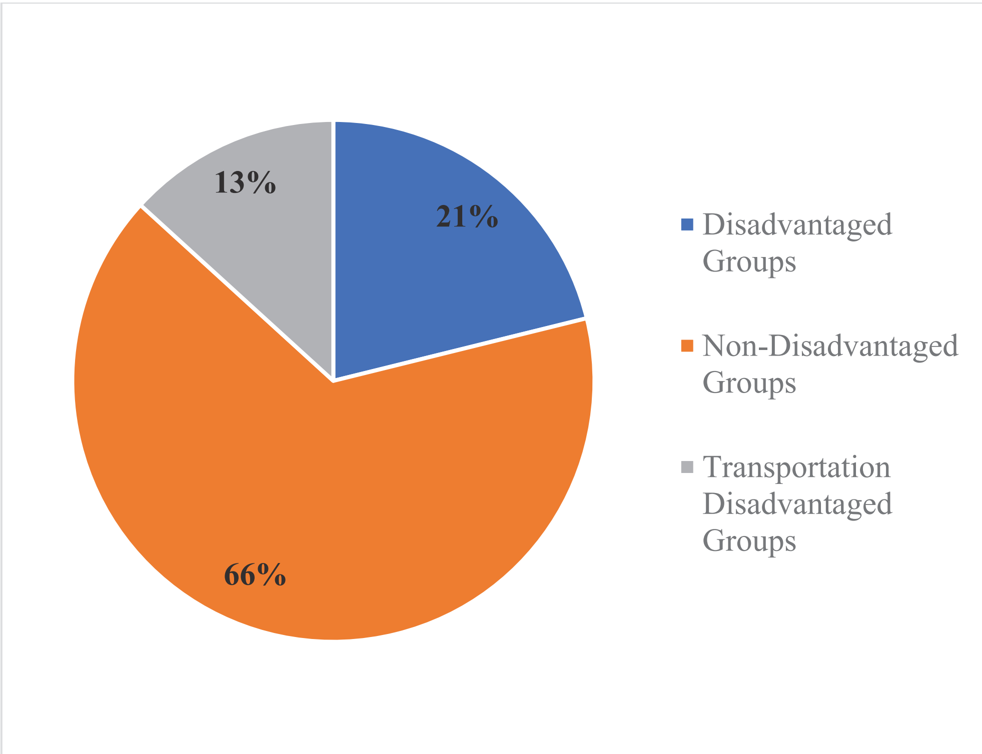


Figure 27. Distribution of purpose of trips over groups

Upon examining the results, individuals mostly undertake their trips for all three purposes, namely work/school, social/leisure/visiting, and shopping. The least common purpose for their travels is shopping. As seen in the figure, the non-disadvantaged groups account for the highest percentage of individuals who travel for all purposes, with 336 individuals or 39%. This is followed by 36% of transportation-disadvantaged groups and

10.40% of disadvantaged groups. For the social/leisure/visiting purpose, 137 individuals or 49.30% of the disadvantaged groups travel, followed by 23.50% of non-disadvantaged groups and 18.40% of transportation-disadvantaged groups. For the work/school purpose, 63 individuals or 36.20% of transportation-disadvantaged groups travel, followed by 30% of non-disadvantaged groups and 11% of disadvantaged groups. For the shopping purpose, 82 individuals or 29.50% of disadvantaged groups travel, followed by 9% of transportation-disadvantaged groups and 7.50% of non-disadvantaged groups within their travels.

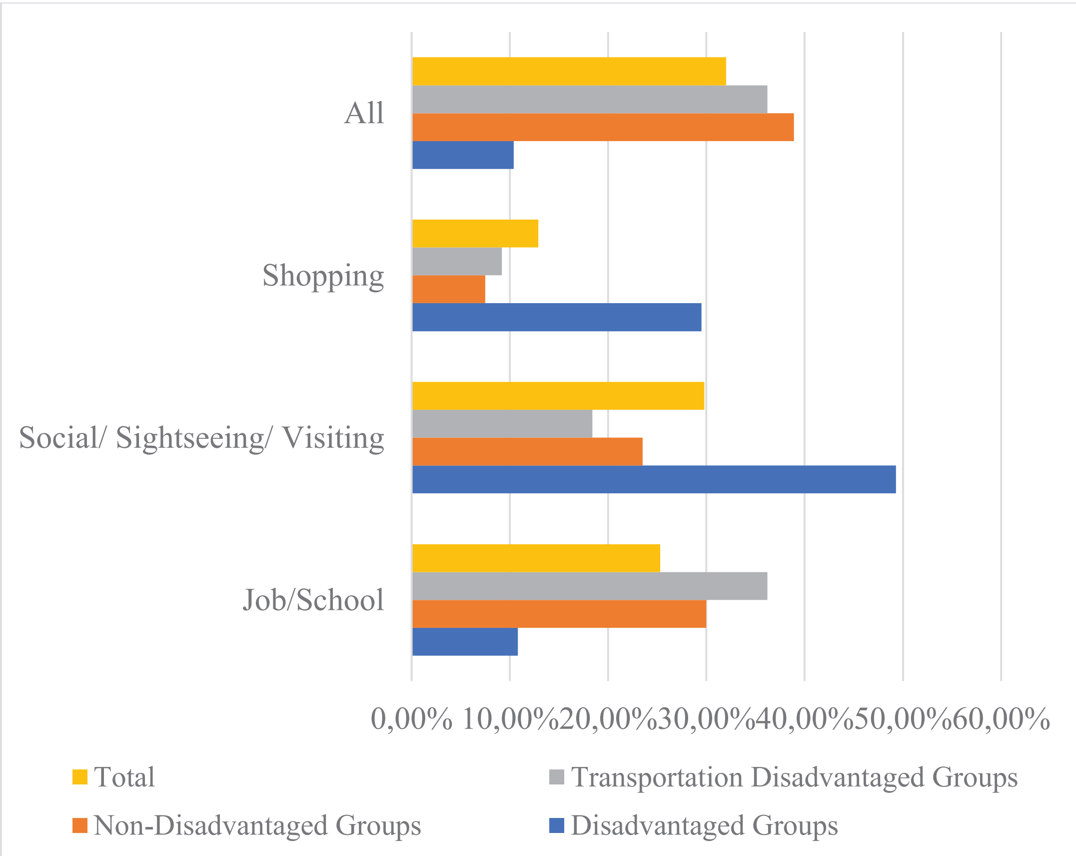


Figure 28. Distribution of Travel Purposes by Groups

According to the results, half of the disadvantaged groups make their trips for social/recreation/visiting purposes. However, transportation-disadvantaged, and non-disadvantaged groups make their trips for work/school purposes.

### 4.2.7. Duration of Journeys

Upon examining all the data, individuals have made a total of 910 selections for the 4 travel durations for the trips they made within Izmir. As seen in the figure, disadvantaged groups made 18%, non-disadvantaged groups made 68%, and transportation-disadvantaged groups made 14% of the markings.

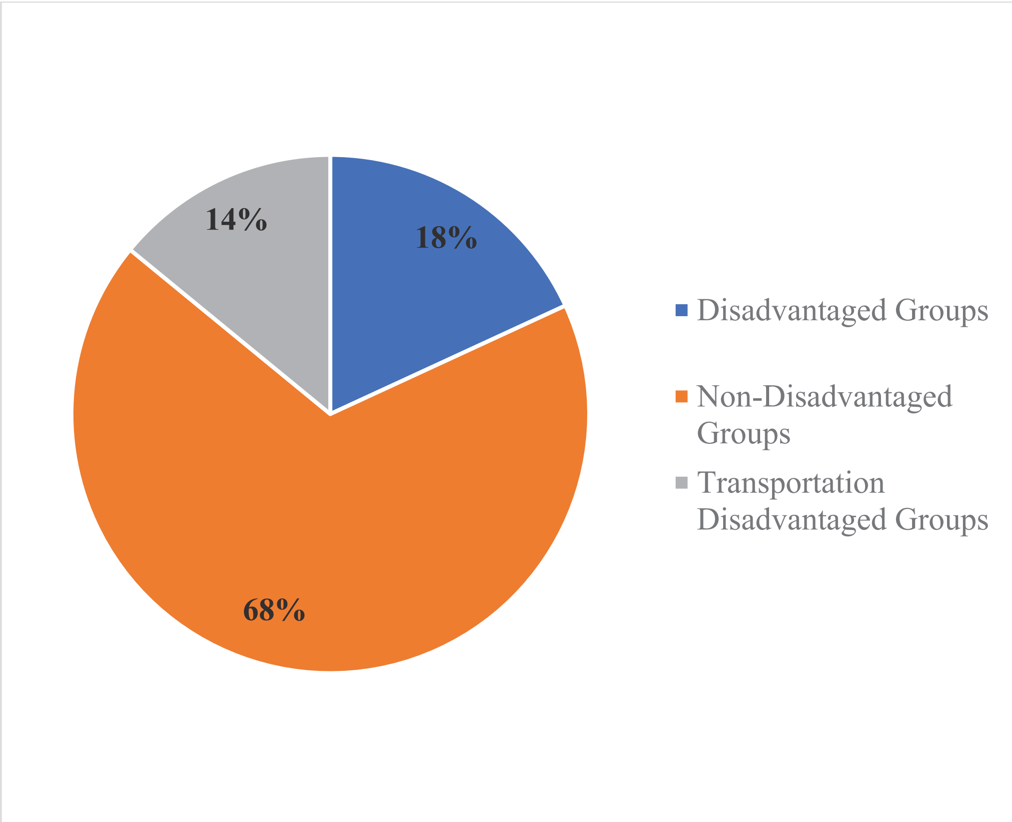


Figure 29. Distribution of the Duration of the Journeys over the groups

Upon examining the results, individuals mostly travel for 30-60 minutes and less than 30 minutes. The minimum travel time is more than 90 minutes. As shown in the figure, non-disadvantaged groups, with 441 individuals or 61.40%, mostly travel for 30-60 minutes. Afterwards, it is 60.90% for disadvantaged groups and 54.40% for transportation-disadvantaged groups. For travel times less than 30 minutes, 55 individuals or 36.90% are from transportation-disadvantaged groups. Afterwards, it is 33.30% for disadvantaged groups and 32.50% for non-disadvantaged groups. For travel times between 60-90 minutes, 8 individuals or 5.40% are from transportation-disadvantaged groups. Afterwards, it is 4.20% for disadvantaged groups and non-disadvantaged groups. For travel times more than 90 minutes, 5 individuals or 3.40% are from transportation-disadvantaged groups. Afterwards, it is 1.90% for non-disadvantaged groups and 1.60% for disadvantaged groups.

According to the results, more than half of all groups perform their journeys in the 30–60-minute range. However, it has been found that disadvantaged transportation groups have a higher proportion of journeys in the "less than 30 minutes", "60-90 minutes", and "more than 90 minutes" categories compared to other groups.

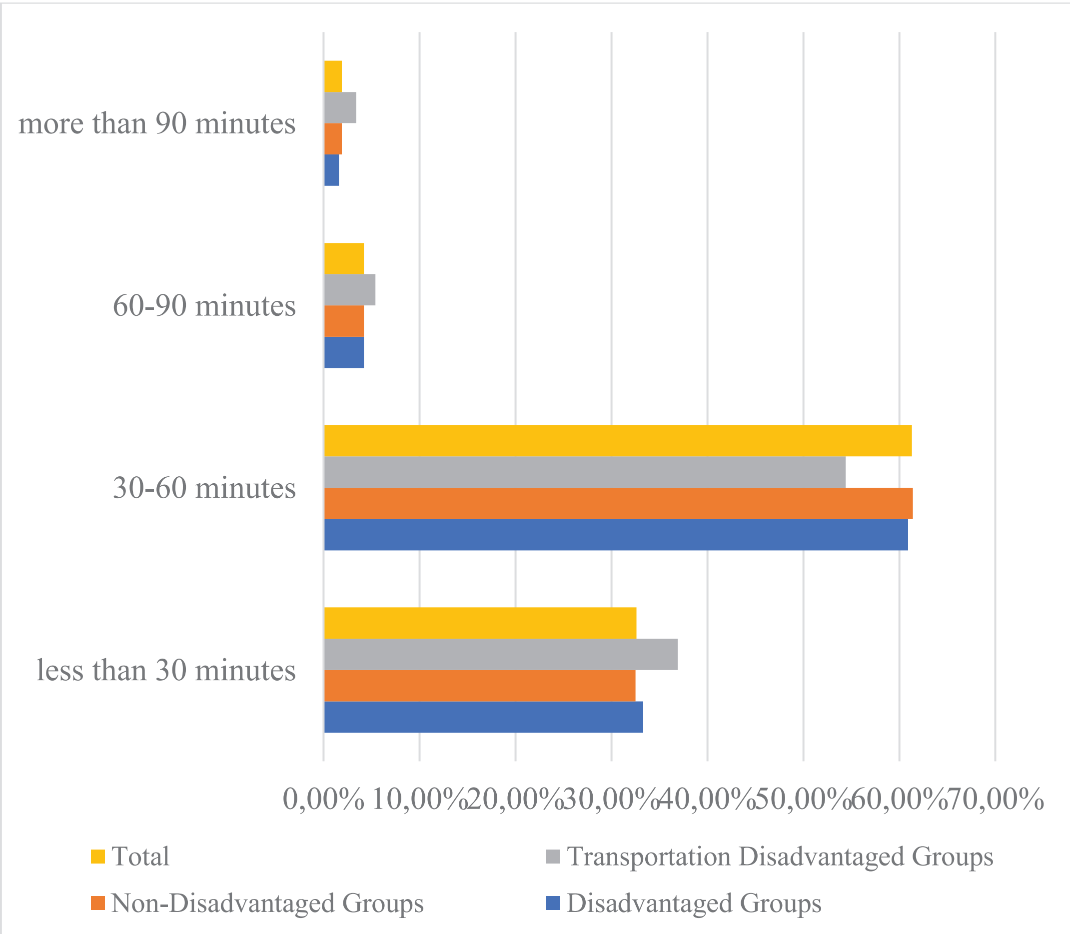


Figure 30. Distribution of Duration of Journeys on the Basis of Groups

According to the results, more than half of all groups perform their journeys in the 30–60-minute range. However, it has been found that disadvantaged transportation groups have a higher proportion of journeys in the "less than 30 minutes", "60-90 minutes", and "more than 90 minutes" categories compared to other groups.

### 4.2.8. Knowing/Being Aware of ITS Applications

According to the results of the study, more than half of all groups are aware of ITS applications, with 88.20% reporting knowledge or awareness, and only 11.80% stating that they do not know or are not aware of the applications. As seen in Figure 2, the disadvantaged groups are the ones who are least knowledgeable about ITS applications. It can be observed that the group with the least number of people who are not knowledgeable about the applications is the transportation disadvantaged group.

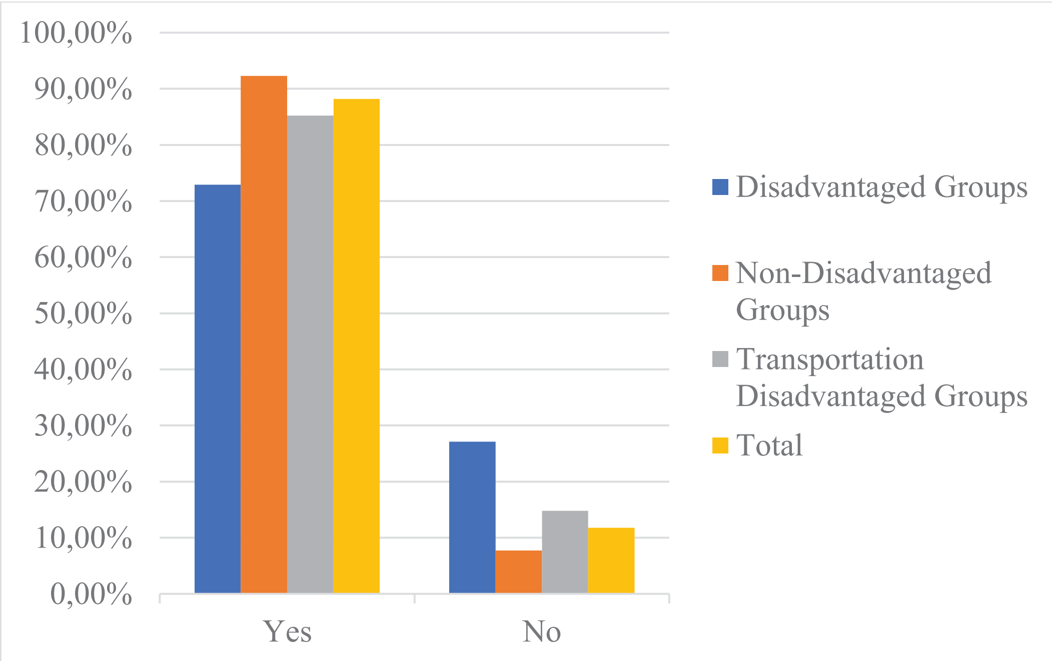


Figure 31. Knowing/Being Aware of ITS Applications on the Basis of Groups

According to the results, it is observed that more than 50% of individuals living in Izmir are aware of the AUS applications. However, it has been found that disadvantaged groups are less familiar with ITS applications compared to other groups.

### 4.2.9. Knowing/Using Mobile Applications from AUS Applications

Upon examining all the data, it was found that more than 50% of individuals living in Izmir are aware of AUS applications. However, disadvantaged groups were found to be less aware of ITS applications compared to other groups. When examined within groups, it was found that the percentage of individuals who do not know or use mobile applications for AUS is 21%. Within disadvantaged groups, this percentage is 53%, while within non-disadvantaged groups, it is 12%, and within transportation disadvantaged groups, it is 22%. As seen in the figure, the percentage of individuals who know or use mobile applications for AUS is 8% within disadvantaged groups, 15% within transportation disadvantaged groups, and 77% within non-disadvantaged groups.

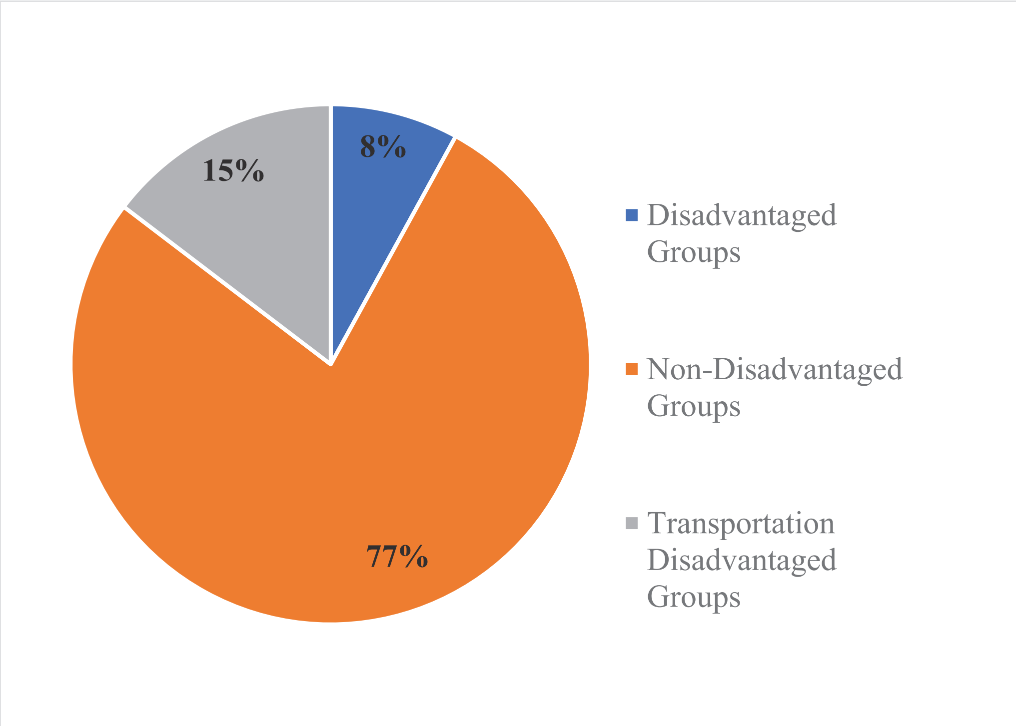


Figure 32.Distribution of Knowing/Using Mobile Applications from AUS Applications by Groups

When the results are examined, it can be seen that individuals mostly use the mobile applications of ITS systems such as Map Applications, ESHOT Mobil, and Kent Kart Mobil during their journeys. The least used mobile applications are İzmir Tarih, Acil İzmir, and KGM Türkiye Trafik. As seen in the figure, when examined within the groups, Map Applications is mostly used by 76 people, which corresponds to 50.30% of disadvantaged groups. After that, 41.20% of transportation-disadvantaged groups and 41.10% of non-disadvantaged groups use it. ESHOT Mobil is mostly used by 301 people, which corresponds to 20.60% of non-disadvantaged groups. After that, 17.30% of transportation-disadvantaged and 10.60% of disadvantaged groups use it. Kent Kart Mobil application is mostly used by 34 people, which corresponds to 12.30% of transportation-disadvantaged groups. After that, 11.90% of disadvantaged and non-disadvantaged groups use it. İzmir Tarih, Acil İzmir, and KGM Türkiye Trafik applications are not used by any individuals from disadvantaged and transportation-disadvantaged groups. However, in non-disadvantaged groups, 0.30% use İzmir Tarih and Acil İzmir, and 0.40% use KGM Türkiye Trafik.

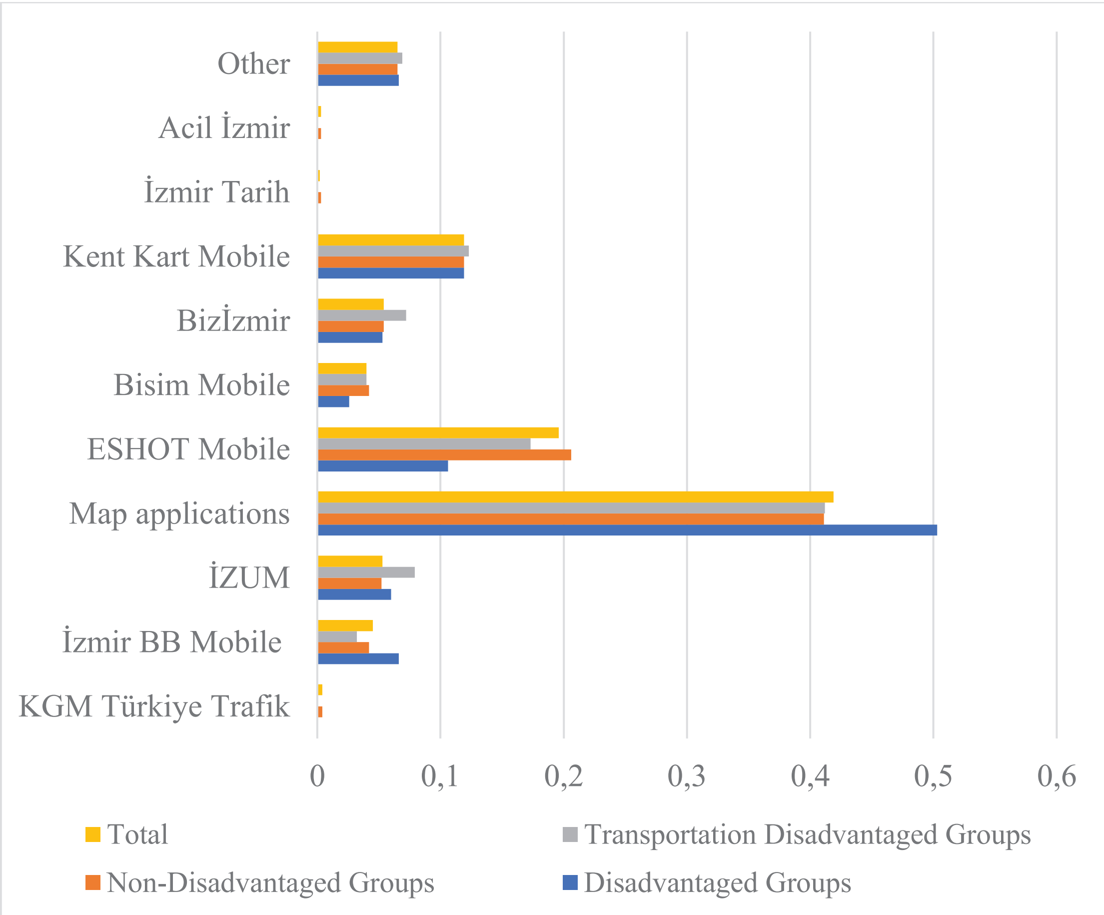


Figure 33.Usage Distribution of Groups from AUS Mobile Applications

According to the results, map applications are the most commonly used ITS mobile applications across all groups. Following map applications, ESHOT Mobile and Kent Kart Mobile are used. Disadvantaged groups use map applications and İzmir BB Mobile applications more than other groups. Disadvantaged groups use ESHOT Mobile and Bisim Mobile applications more than other groups. In transportation disadvantaged groups, Kent Kart Mobile, Bizİzmir, and İZUM applications are used more than other groups.

### 4.2.10. Knowing/Using ITS Apps Used While Traveling

Upon examining all the data, it was found that the percentage of individuals who do not know or use any ITS applications while traveling is 0.9%. When examined by groups, it was found that the percentage of individuals who do not know or use any AUS applications while traveling is 3.6% for disadvantaged groups, 0.1% for non-disadvantaged groups, and 2.7% for transportation-disadvantaged groups. As shown in the figure, among the groups who use or know about ITS applications while traveling, it is observed that disadvantaged groups constitute 15% of the total, transportation-disadvantaged groups constitute 13%, and non-disadvantaged groups constitute 72%.

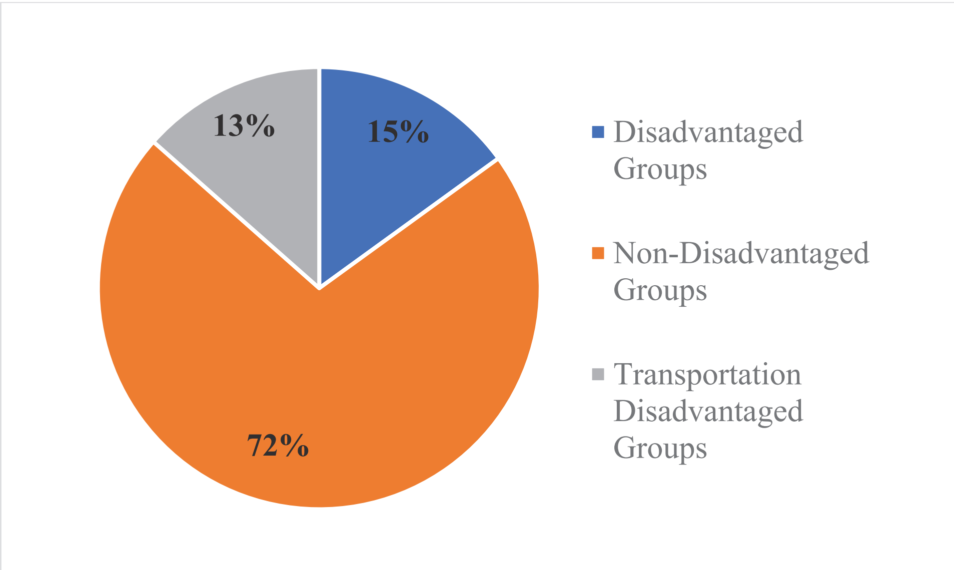


Figure 34. Distribution of Knowing/Using ITS Applications Used While Traveling by Groups

Upon examination of the data, it was found that the most commonly used ITS applications by individuals during travel are Smart pedestrian crossing system, Smart Stop, Variable Message Signs, and HGS_OGS_KGS. The least used applications are Other, İZUM, and Moovit. As seen in the figure, when examined by groups, Smart pedestrian crossing system is used the most by disadvantaged groups with 166 people or 22.30%, followed by 20.20% transportation-disadvantaged groups and 19% non-disadvantaged groups. Smart Stop is used the most by disadvantaged groups with 163 people or 21.90%, followed by 19.90% transportation-disadvantaged and 18.80% non-disadvantaged groups. Variable Message Signs is used the most by disadvantaged groups with 166 people or 22.30%, followed by 18.50% non-disadvantaged groups and 18.40% transportation-disadvantaged groups. For Other, 7 people or 0.20% of non-disadvantaged groups, 0.10% of transportation-disadvantaged groups use it, while disadvantaged groups do not use it. İZUM and Moovit are used the least by disadvantaged groups. Non-disadvantaged and transportation-disadvantaged groups use them equally.

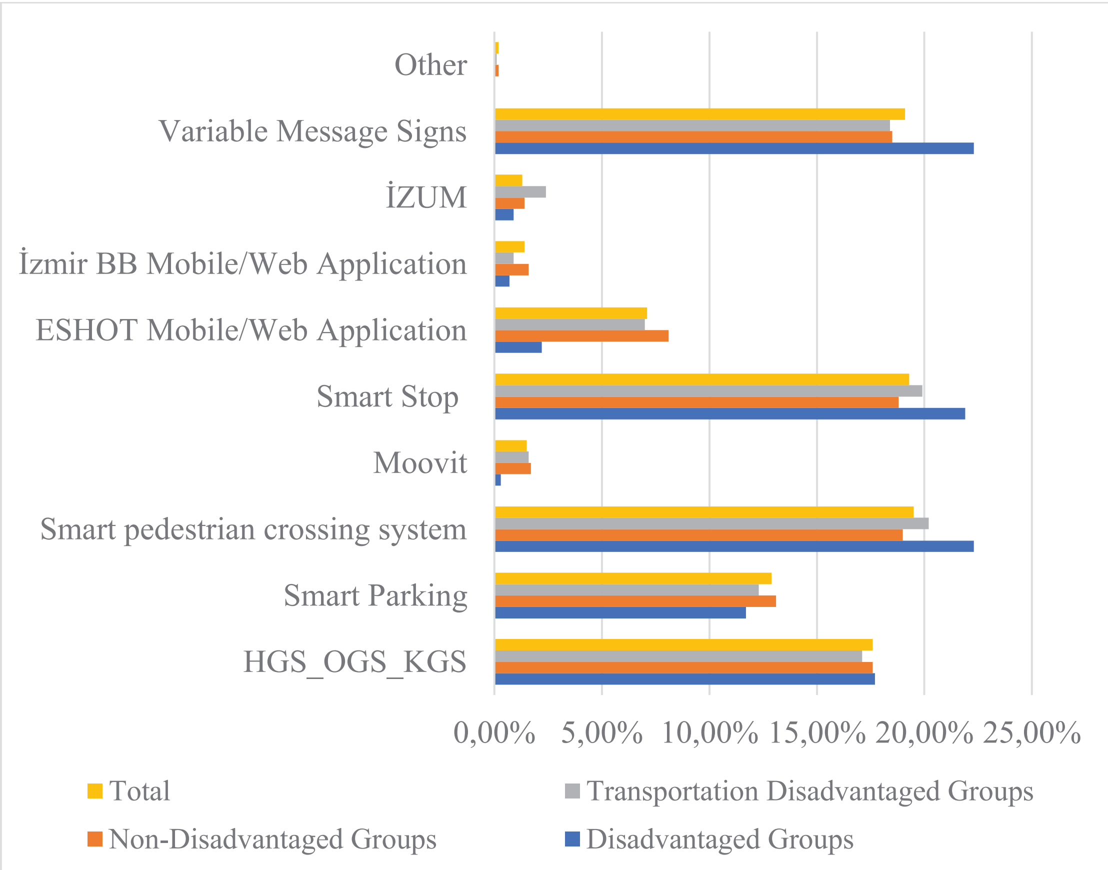


Figure 35. Distribution of Use of ITS Applications While Traveling by Groups

In conclusion, it was observed that 96.4% of disadvantaged groups use ITS applications when traveling. Smart pedestrian crossing system, Smart Stop, Variable Message Signs, and HGS_OGS_KGS are the most commonly used applications among all groups. Accordingly, people seem to be more familiar with ITS applications that provide objective information compared to mobile applications. They have clearly adapted their daily travel routines using these applications.

### 4.2.11. Knowing/Using AUS Applications Used in Public Transport

Upon examining all the data, it was observed that the percentage of people who are unaware of or do not use ITS applications in public transportation is 2.3%. When examined within the groups, it was found that the percentage of those who are unaware of or do not use ITS applications is 7.3% in disadvantaged groups, 1% in non-disadvantaged groups, and 2.7% in transportation-disadvantaged groups. As seen in the figure, among the groups who use or are aware of ITS applications during their travels, the percentage is 16% in disadvantaged groups, 14% in transportation-disadvantaged groups, and 70% in non-disadvantaged groups.

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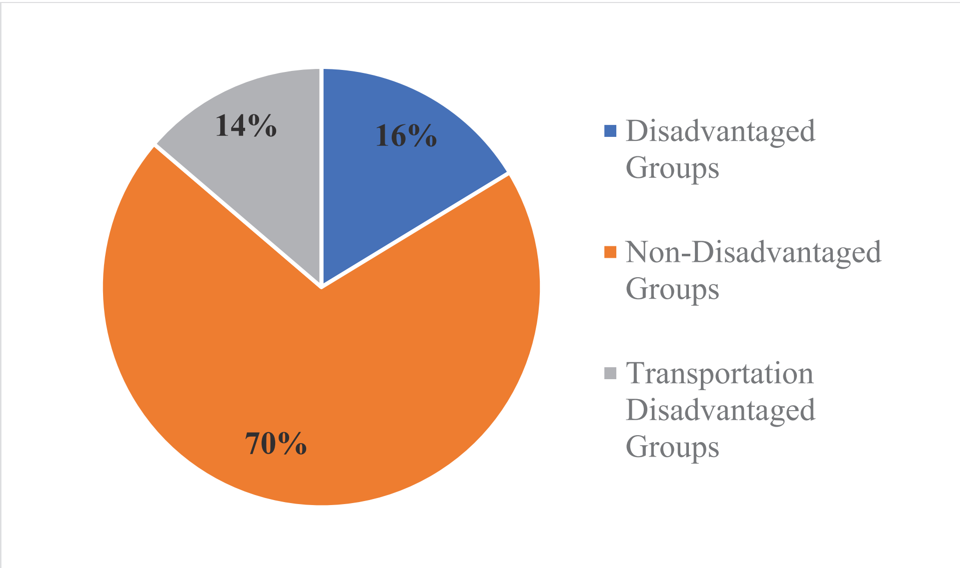


Figure 36. Distribution of Knowing/Using AUS Applications Used in Public Transport by Groups

When the results are examined, individuals mostly use İzmirKart, Smart Stop, Passenger Information System, and Smart pedestrian crossing system among the ITS applications used in public transportation. The least used applications are Other, İzmir BB Mobile, and Moovit. As seen in the figure, İzmirKart is mostly used by 175 people or 21.30% of disadvantaged groups. Afterwards, 20.10% of transportation disadvantaged groups and 19.60% of non-disadvantaged groups use it. Smart Stop is mostly used by 164 people or 20% of disadvantaged groups. Afterwards, 19.30% of transportation disadvantaged and 19.10% of non-disadvantaged groups use it. Passenger Information

System is mostly used by 160 people or 19.50% of disadvantaged groups. Afterwards, 18.90% of non-disadvantaged groups and 18.80% of transportation disadvantaged groups use it. Smart pedestrian crossing system is mostly used by 159 people or 19.30% of disadvantaged groups. Afterwards, 19% of transportation disadvantaged and 18.90% of non-disadvantaged groups use it. For Other, 47 people or 1.30% of non-disadvantaged groups and 0.90% of transportation disadvantaged groups use it. Disadvantaged groups do not use it. İZUM and Moovit applications are used by disadvantaged groups in the least amount. Non-disadvantaged and transportation disadvantaged groups use them in equal proportions.

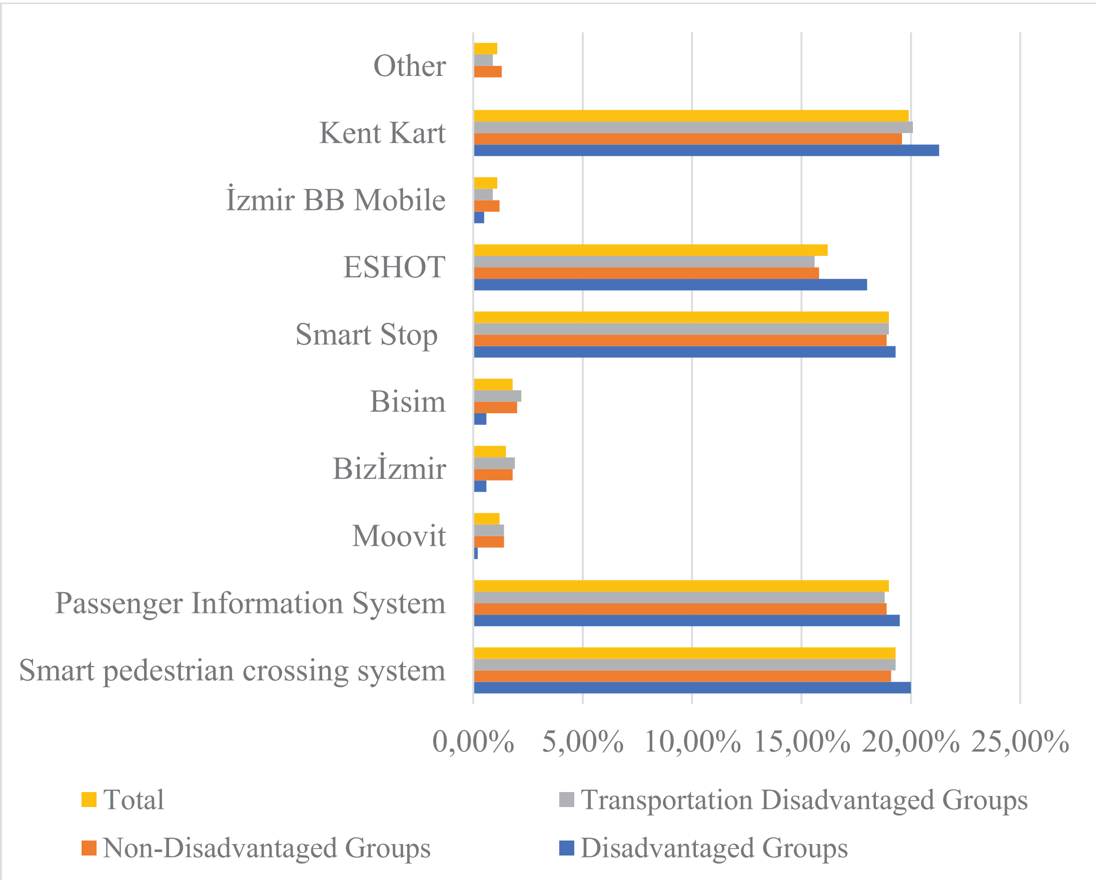


Figure 37. Usage Distribution of ITS Applications Used in Public Transport by Groups

In ITS applications used in public transportation, it has been observed that disadvantaged groups and transportation-disadvantaged groups use over 90% of the applications. Among all groups, the most used applications are İzmirKart, Smart Stop, Passenger Information System, and Smart pedestrian crossing system. Accordingly, disadvantaged groups are the most active users of public transportation systems.

### 4.2.12. Degree of Satisfaction with ITS Applications

When looking at people's satisfaction with ITS applications, it was observed that the highest rate of satisfaction was observed in all groups. As shown in Figure 5, 585 people, or 81.50% of non-disadvantaged groups, 155 people, or 80.70% of disadvantaged groups, and 108 people, or 72.50% of transportation disadvantaged groups were satisfied. Only 4 people, or 2.70% of transportation disadvantaged groups, 4 people, or 2.10% of disadvantaged groups, and 6 people, or 0.80% of non-disadvantaged groups, expressed that they were "not satisfied at all". 21 people, or 14.10% of transportation disadvantaged groups, 90 people, or 12.50% of non-disadvantaged groups, and 21 people, or 10.90% of disadvantaged groups, expressed that they were "very satisfied". In the case of "not satisfied", it can be seen that transportation disadvantaged groups are more than disadvantaged groups, with a rate of 10.70%.

The average degree of "satisfaction" is 81.30%. Disadvantaged and transportation disadvantaged groups fall below the average, while non-disadvantaged groups are above the average. In the case of "very satisfied", transportation disadvantaged groups stand out by being above the average. In the case of "Very dissatisfied", disadvantaged and transportation disadvantaged groups are above the average.

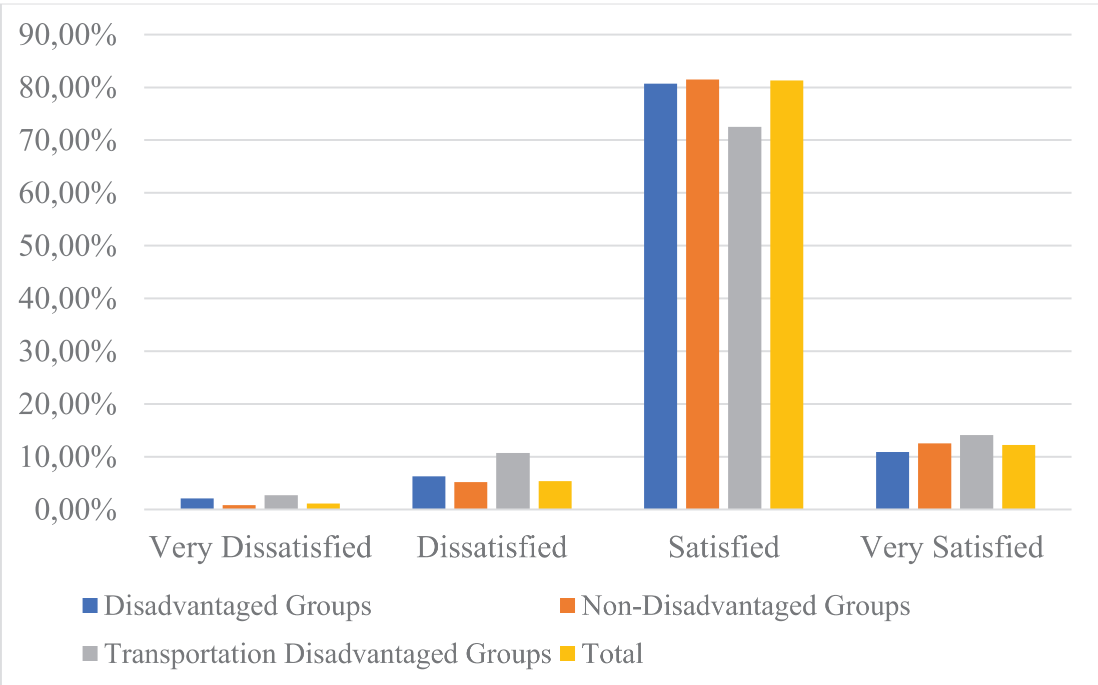


Figure 38. Individuals' Satisfaction Levels with ITS Applications on the Basis of Groups

According to the results, there is a very small difference of only %0.80 between the satisfaction levels of disadvantaged and non-disadvantaged groups in the "satisfied" category. There is a %8.20 difference between disadvantaged transportation groups and other groups. Therefore, it is revealed that disadvantaged and non-disadvantaged groups are satisfied with ITS applications, but transportation-disadvantaged groups are less satisfied than other groups.

### 4.2.13. Frequency of Use of ITS Applications during the Day

According to the results, there is a very small difference of 0.80% between the disadvantaged and non-disadvantaged groups in terms of their satisfaction with ITS applications. There is an 8.20% difference in transportation between disadvantaged and non-disadvantaged groups. Therefore, it has been revealed that disadvantaged and non-disadvantaged groups are satisfied with ITS applications, but transportation-disadvantaged groups are less satisfied than other groups.

When looking at people's usage patterns of ITS applications during the day, it was observed that the highest percentage of usage was "1-2 times". As shown in Figure 6, 552 people, or 76.90% of non-disadvantaged groups, 146 people, or 76% of disadvantaged groups, and 99 people, or 66.40% of transportation-disadvantaged groups, used ITS applications "1-2 times" per day. Disadvantaged and transportation-disadvantaged groups have equal percentages of "never used" ITS applications during the day at 16.10%, while the percentage for non-disadvantaged groups is 7.50%. Disadvantaged groups do not use ITS applications more than "5 times" per day. "5 times or more" is used the most by non-disadvantaged groups at a rate of 2.40%.

The average usage of "1-2 times" per day is 76.70%. Disadvantaged and transportation-disadvantaged groups are below the average, while non-disadvantaged groups are above the average. However, the opposite is true for "never used". The average for "never used" is 9.30%. Non-disadvantaged groups are below the average at 7.50%, while disadvantaged and transportation-disadvantaged groups are above the average at 16.10%.

According to the results, there is a very small difference of 0.90% between disadvantaged and non-disadvantaged groups in the frequency of using ITS applications "1-2 times" during the day. However, there is a difference of 10.5% among transportation-disadvantaged groups. Therefore, it has been revealed that disadvantaged and non-disadvantaged groups use ITS applications "1-2 times" per day, but transportation-disadvantaged groups use them less frequently than other groups.

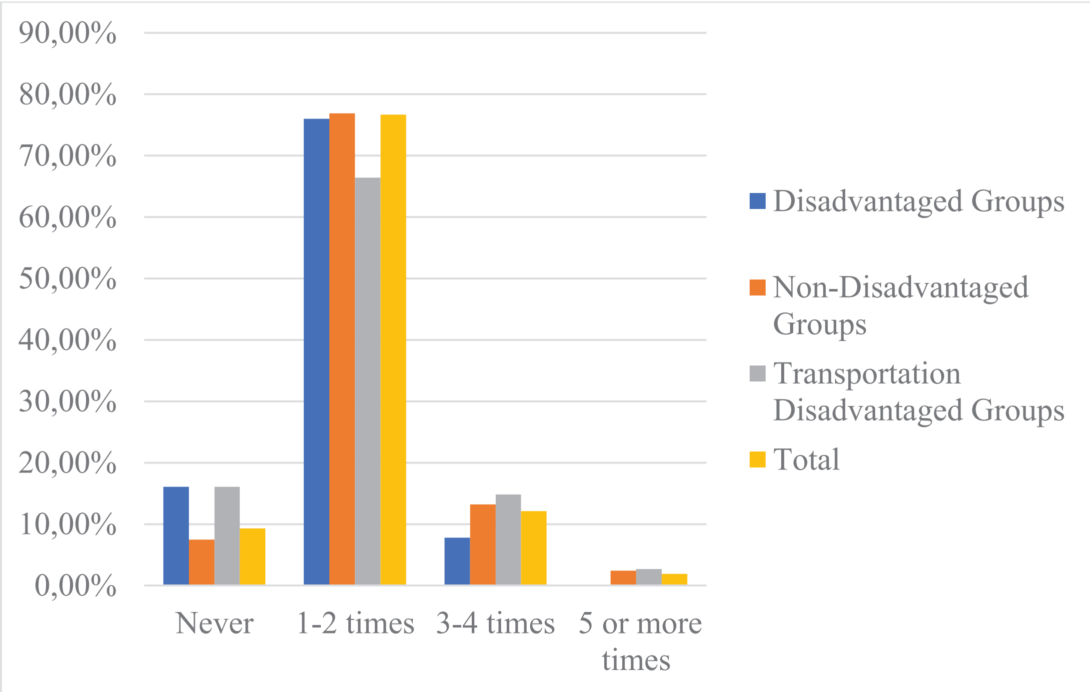


Figure 39. Daily ITS Usage Distribution of Individuals on the Basis of Groups

### 4.2.14. Ease of Access Using AUS Applications

When looking at whether they were able to access their jobs on time using ITS applications, it was observed that they had the highest rate of access. As shown in Figure 6, 539 people or 75.10% of non-disadvantaged groups, 140 people or 72.90% of disadvantaged groups, and 99 people or 66.40% of transportation disadvantaged groups were observed to have access. 23.50% of transportation disadvantaged groups, 20.20% of non-disadvantaged groups, and 15.60% of disadvantaged groups were observed to have "partial" access to their jobs using the applications. It was observed that those who did not have access to their jobs using the applications were mostly disadvantaged and transportation disadvantaged groups.

Individuals stated that they accessed their jobs on time at a rate of 74.6% using AUS applications. When examined by groups, only non-disadvantaged groups were above average, while disadvantaged and transportation disadvantaged groups were below average. 6.2% of all individuals stated that they had problems accessing their jobs on time. Disadvantaged and transportation disadvantaged groups also had above-average results, while non-disadvantaged groups were below average. Thus, it appears that transportation disadvantaged groups have more problems accessing their jobs on time.

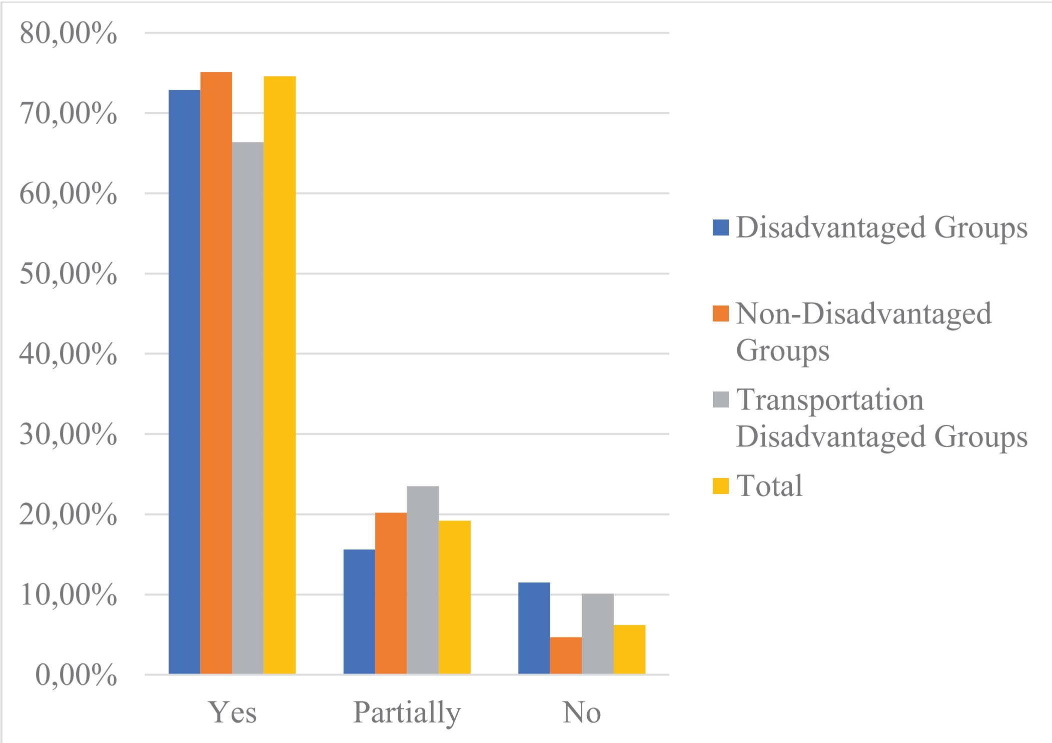


Figure 40. Distribution of Ease of Access by Individuals Using ITS Applications on the Basis of Groups

According to the results, there is a 2.20% difference in ease of access using the ITS applications between disadvantaged and non-disadvantaged groups. Among transportation disadvantaged groups, there is a 6.50% difference. Therefore, it can be seen that disadvantaged and non-disadvantaged groups are able to access their work in a timely manner using ITS applications, but it is observed that transportation disadvantaged groups have less access compared to other groups.

### 4.2.15. Comfort of Travel with AUS Applications

When examining whether journeys with ITS applications were comfortable, it was observed that they were mostly comfortable. As shown in Figure 6, 557 people, or 76.60%

of non-disadvantaged groups, 144 people, or 75% of disadvantaged groups, and 94 people, or 63.10% of transportation-disadvantaged groups, answered "yes." It was observed that 22.80% of transportation-disadvantaged groups, 18% of non-disadvantaged groups, and 14.60% of disadvantaged groups responded "partially" comfortable during their journeys. It was observed that the most disadvantaged and transportation-disadvantaged groups had the highest rate of discomfort during their journeys with ITS applications

Individuals stated that they were comfortable during their journeys using AUS applications with a rate of 77%. When examined by groups, only non-disadvantaged groups were above average, while disadvantaged and transportation-disadvantaged groups were below average. Among all individuals, 5.70% stated that they could not make comfortable journeys with the applications. In groups, disadvantaged and transportation-disadvantaged groups had above-average results, while non-disadvantaged groups were below average. Therefore, it appears that transportation-disadvantaged groups have more problems with comfortable journeys.

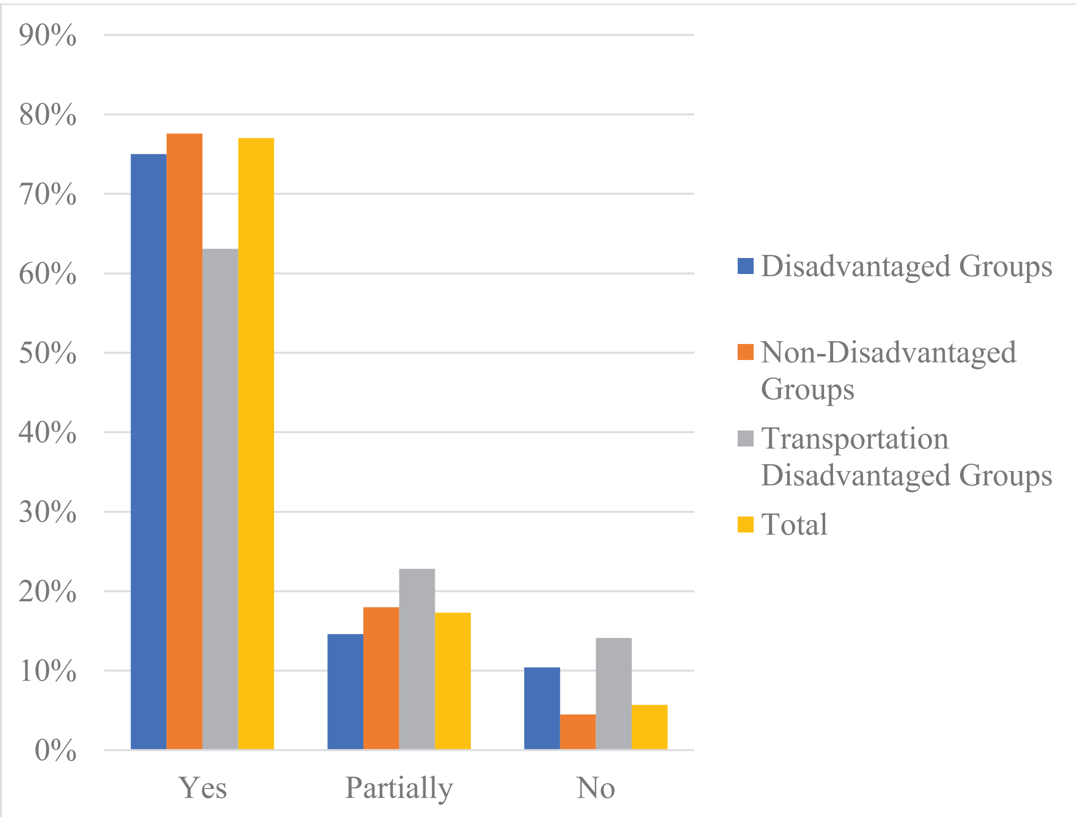


Figure 41. Distribution of Individuals' Travel Comfort with ITS Applications on the Basis of Groups

According to the results, there is a difference of 2.60% between disadvantaged and non-disadvantaged groups in terms of comfortably using ITS applications during travel. However, there is a difference of 11.90% among transportation disadvantaged groups. Therefore, disadvantaged, and non-disadvantaged groups are able to travel comfortably with ITS applications, but it can be seen that transportation disadvantaged groups have less comfortable experiences compared to other groups.

### 4.2.16. Economic (Material) Impact of ITS Applications

When examining the economic impact of ITS applications, it is observed that they have the highest level of impact. As shown in Figure 6, 127 people, or 66% of disadvantaged groups, 76 people, or 51% of transportation disadvantaged groups, and 330 people, or 46% of non-disadvantaged groups responded "yes". It was observed that there was a "partially" effect in the travel of 10% of non-disadvantaged groups, 7.40% of transportation disadvantaged groups, and 6.80% of disadvantaged groups. The highest proportion of respondents who indicated that ITS applications had no economic impact were non-disadvantaged and transportation disadvantaged groups.

Individuals reported that their journeys had an economic impact of 50% when using AUS applications. When examined by groups, it was observed that disadvantaged and transportation disadvantaged groups were above average, but non-disadvantaged groups were below average. 40.30% of all individuals stated that the applications had no economic impact. By group, non-disadvantaged and transportation disadvantaged groups had above-average results, while disadvantaged groups were below average. Accordingly, it was found that disadvantaged groups did not experience economic problems with the applications.

According to the results, there is a 20% difference between disadvantaged and non-disadvantaged individuals in terms of the economic impact of ITS applications. In the case of transportation-disadvantaged groups, this difference is 15%. This is due to the fact that disadvantaged individuals benefit from free public transportation, which has an economic impact on them.

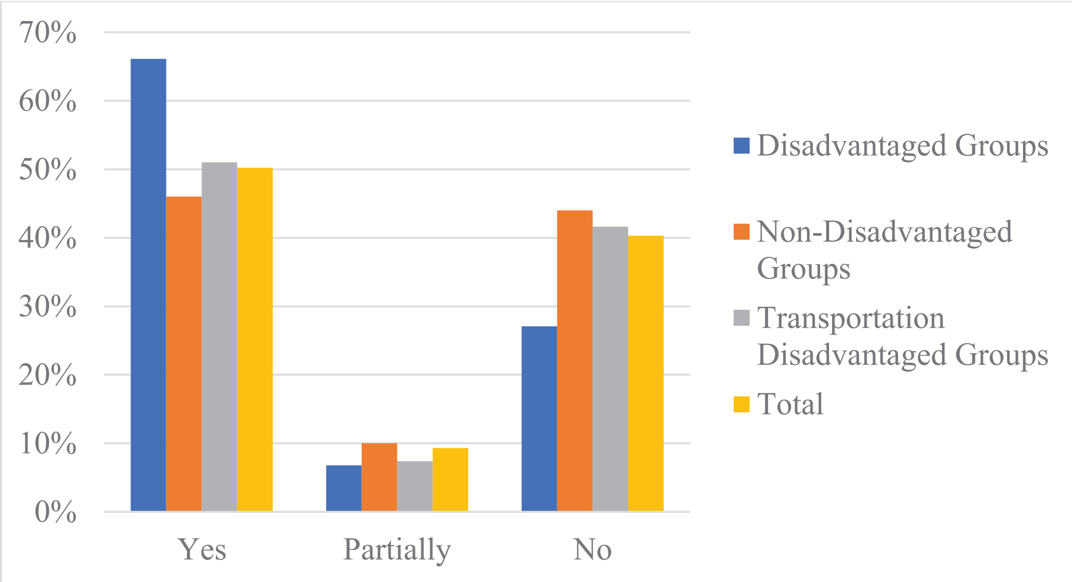


Figure 42. Distribution of Economic Impact of Individuals' ITS Applications by Groups

### 4.2.17. Positive Contribution of ITS Applications in Daily Life

When considering the positive contributions of Intelligent Transportation Systems (ITS) in daily life, it is observed that they have the most significant positive impact. As shown in Figure 6, 572 people, or 79.70% of the non-disadvantaged groups, 143 people, or 74.50% of the disadvantaged groups, and 108 people, or 72.50% of the transportation-disadvantaged groups, responded "yes." Partially positive contributions were observed in 13.50% of the non-disadvantaged groups, 12% of the disadvantaged groups, and 10.70% of the transportation-disadvantaged groups during their journeys. The lack of positive contributions of ITS applications in daily life was observed to be most significant in disadvantaged and transportation-disadvantaged groups.

Individuals stated that ITS applications have a positive contribution of 78%. When examined by groups, only the non-disadvantaged groups are above the average, while disadvantaged and transportation-disadvantaged groups are below the average. 8.20% of all individuals stated that ITS applications do not have a positive effect on their daily lives and disadvantaged and transportation-disadvantaged groups had above-average results, while non-disadvantaged groups were below average. Therefore, it appears that disadvantaged groups experience more problems regarding the positive contributions of ITS applications in their daily lives.

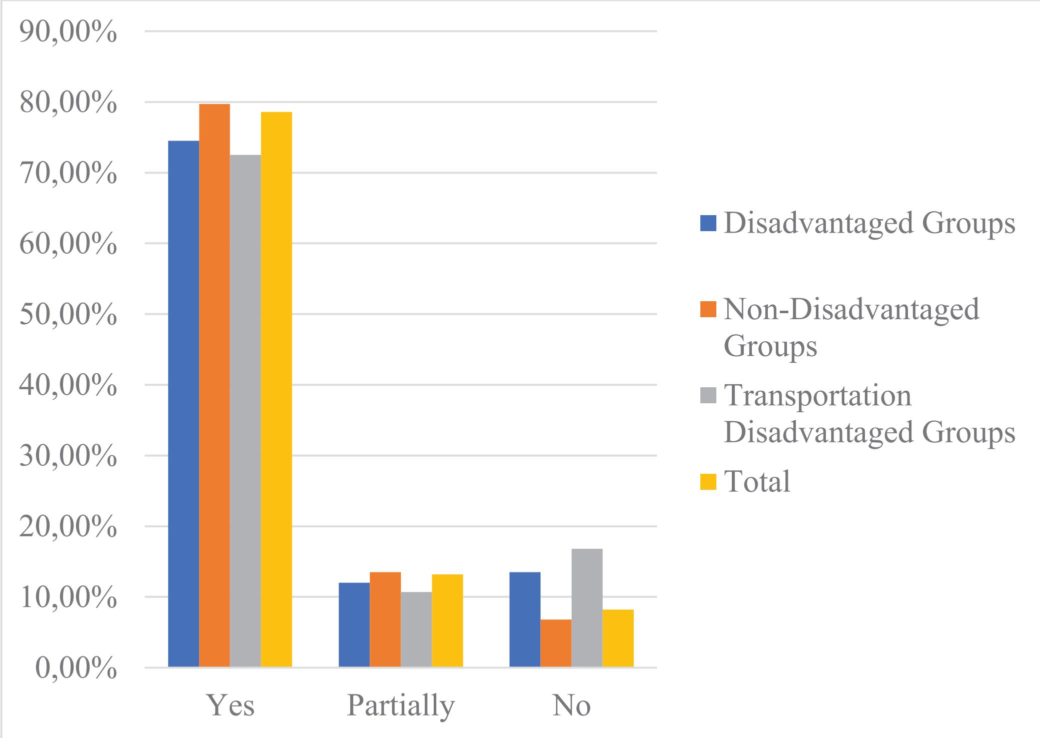


Figure 43. Distribution of the Positive Contribution of Individuals' ITS Applications to Daily Life on the Basis of Groups

According to the results, there is a 5.20% difference between disadvantaged and non-disadvantaged groups regarding the positive contribution of ITS applications in daily life. For transportation-disadvantaged groups, there is a 2% difference. Therefore, it is seen that non-disadvantaged groups benefit more from ITS applications. Due to the lack of applications that cater to the needs of disadvantaged and transportation-disadvantaged groups, individuals in these groups experience more negative effects in their daily lives.

### 4.2.18. Having Problems Using ITS Applications

When looking at whether individuals experienced any problems while using ITS applications, the highest percentage of respondents reported not experiencing any problems. As shown in Figure 6, 177 individuals, or 92.20% of disadvantaged groups, 575 individuals, or 80.10% of non-disadvantaged groups, and 96 individuals, or 64.40% of transportation-disadvantaged groups were reported as answering "no". 35.60% of transportation-disadvantaged groups, 19.90% of non-disadvantaged groups, and 7.80%

of disadvantaged groups were reported as experiencing problems while using the applications.

Overall, 82.60% of respondents reported not experiencing any problems while using ITS applications. When examined by group, only disadvantaged groups were above average, with non-disadvantaged and transportation-disadvantaged groups below average. Of all respondents, 17.40% reported experiencing problems while using the applications, with both transportation-disadvantaged and non-disadvantaged groups performing above average and disadvantaged groups performing below average. Therefore, it appears that transportation-disadvantaged groups experience more problems while using ITS applications.

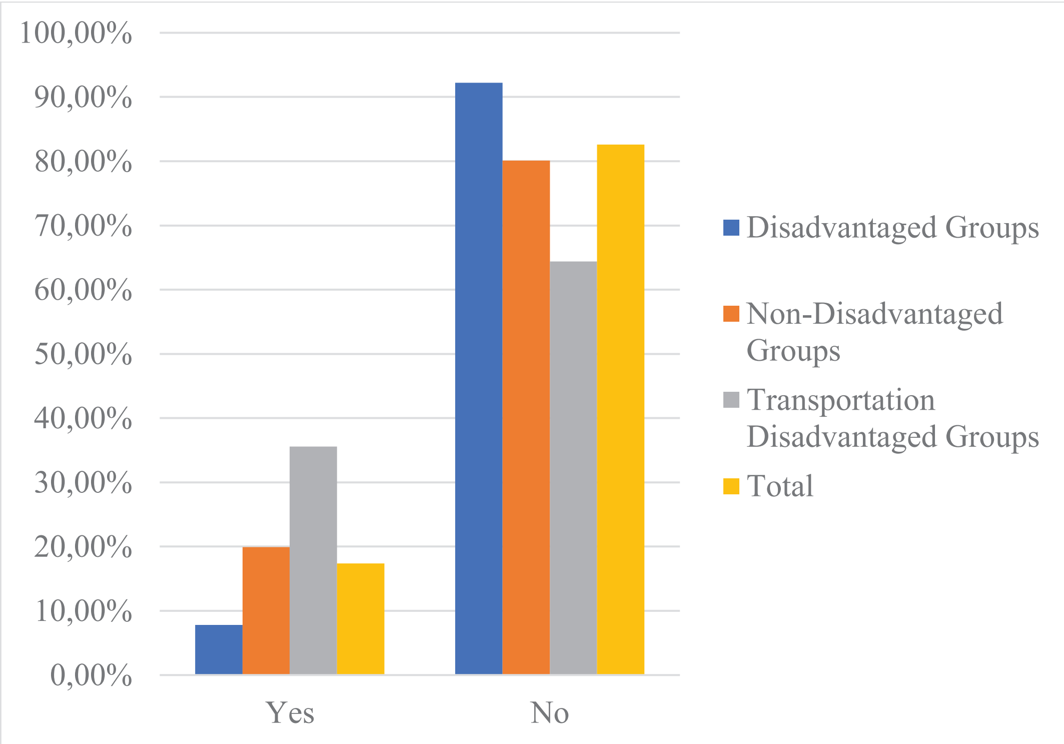


Figure 44. Distribution of Individuals Having Problems Using ITS Applications on the Basis of Groups

According to the results, there is a difference of 12.10% between disadvantaged and non-disadvantaged groups in terms of experiencing problems while using ITS applications. Among transportation-disadvantaged groups, this difference is 27.80%. Thus, it is observed that groups who feel transportation-disadvantaged experience more problems while using the application.

### 4.2.19. The Most Important Problems Encountered in Transportation

Upon examining all the data, it is found that there is a percentage of 0.8 of individuals who do not experience significant problems in transportation. When examined within the groups, it is revealed that there is a percentage of 2.1 in disadvantaged groups, 0.4 in non-disadvantaged groups, and 0 in transportation-disadvantaged groups who do not experience significant problems in transportation. As shown in the figure, it is observed that the percentage of individuals who experience significant problems in transportation is 17% in disadvantaged groups, 14% in transportation-disadvantaged groups, and 69% in non-disadvantaged groups.

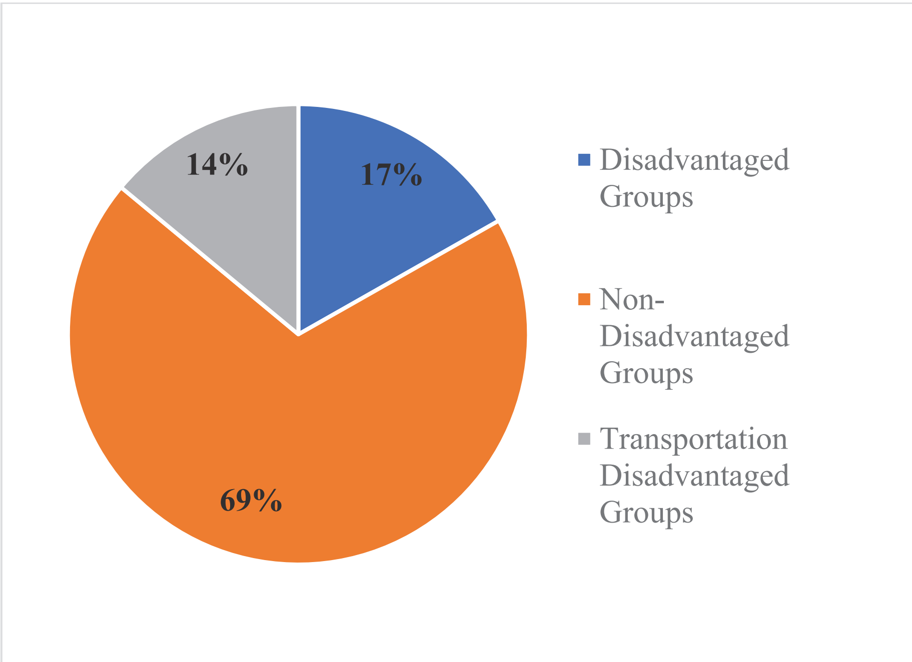


Figure 45. Distribution of the Most Important Problems Encountered in Transportation by Groups

When the results are examined, it is found that the most important problems individuals face in transportation are Traffic congestion, Parking difficulties, and inadequacy of public transportation vehicles. The least problematic issues are Other and outdated public transportation vehicles. As shown in the figure, when examined within groups, Traffic congestion is experienced the most by 621 people, or 28.90% of those who are not disadvantaged. Following them, 28.80% of disadvantaged groups and 27.50% of transportation-disadvantaged groups experience traffic congestion. Parking difficulties are experienced the most by 408 people, or 19% of those who are not disadvantaged. Following them, 18.50% of disadvantaged and 15.70% of transportation-disadvantaged groups experience parking difficulties. Inadequacy of public transportation vehicles is experienced the most by 84 people, or 19.40% of transportation-disadvantaged groups. Following them, 17.30% of those who are not disadvantaged and 16.80% of disadvantaged groups experience this problem. Other problems are experienced the most by 12 people, or 2.80% of transportation-disadvantaged groups, 14% of disadvantaged groups, and 1.20% of those who are not disadvantaged. Outdated public transportation vehicles are a problem for the most 59 people, or 11.30% of disadvantaged groups. Following them, 11.10% of transportation-disadvantaged groups and 8.60% of those who are not disadvantaged experience this problem.

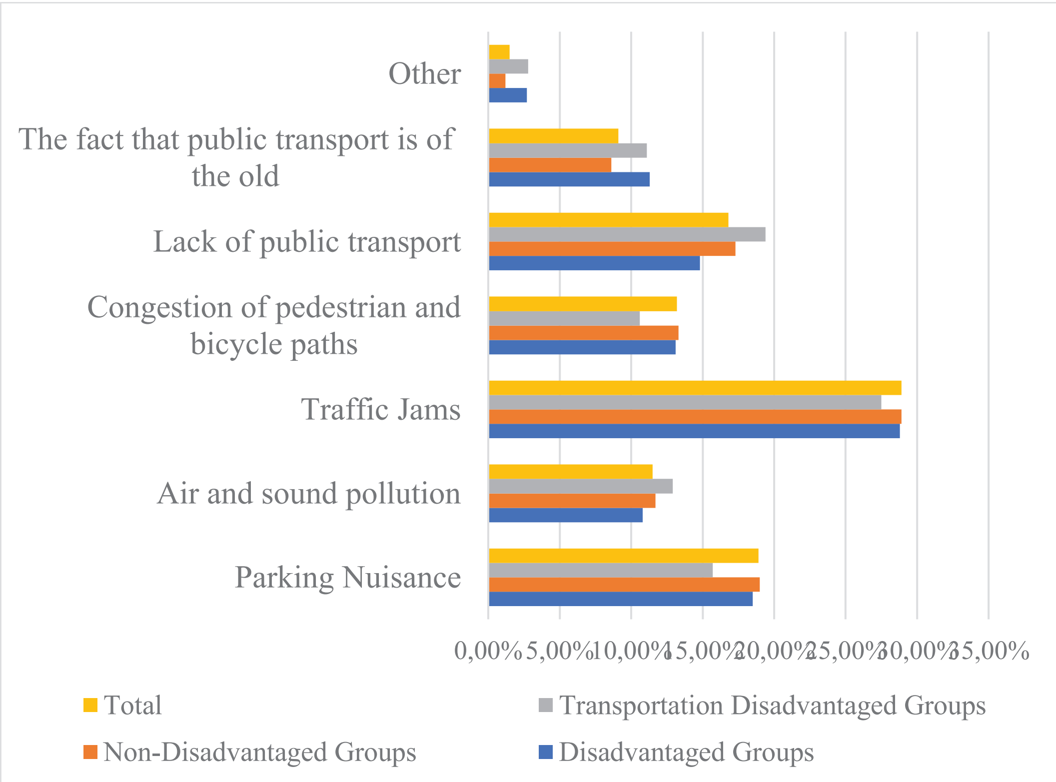


Figure 46. Distribution of the Most Important Problems Encountered by Individuals in Transportation on the Basis of Groups

Upon examining all the data, it was found that 85.4% of individuals reported experiencing the most significant transportation problems as traffic congestion, followed by 55.8% reporting parking difficulties.

## 4.3. Statistical Tests (One-Way ANOVA)

Hypotheses were tested in the statistical analyses. The acceptance or rejection of the hypotheses was evaluated based on the One-Way ANOVA analyses of the research data in the SPSS program. The decisions and interpretations of the hypotheses are described in detail below in a sequential manner.

### 4.3.1. Decision and Interpretation of Hypothesis 1

There is a significant difference in people's awareness of intelligent transportation system applications.

Table 11. ANOVA results of Hypothesis 1 awareness rates between groups.

| Groups | N | X | SD | Source of variance | Sum of Squares | df | Mean Square | F | P | Significance |
|---|---|---|---|---|---|---|---|---|---|---|
| Disadvantaged Groups | 191 | 0,73 | 0,44 | B.G | 5,593 | 2 | 2,797 | 27,595 | ,001 | 2-1,3<br>3-1 |
| Non-Disadvantaged Groups | 718 | 0,92 | 0,26 | W.G. | 106,921 | 1055 | 0,101 | | | |
| Transportation Disadvantaged Groups | 149 | 0,85 | 0,35 | Total | 112,514 | 1057 | | | | |
| Total | 1058 | 0,88 | 0,32 | | | | | | | |

There is a significant difference in the awareness rates of people regarding intelligent transportation system applications between groups (F: 27.595; $p < 0.05$). According to the results of the LSD test conducted to indicate which groups show differences in the awareness rates of people regarding smart transportation system applications, it has been determined that non-disadvantaged groups have higher awareness rates (X: 0.92) compared to transportation-disadvantaged groups (X: 0.85) and disadvantaged groups (X: 0.73). Additionally, it has been found that the awareness rates of transportation-disadvantaged groups (X: 0.85) are higher than disadvantaged groups (X: 0.73).

### 4.3.2. Decision and Interpretation of Hypothesis 2

There is a significant difference in the satisfaction levels of individuals with intelligent transportation system applications across groups.

Table 12. ANOVA results of Hypothesis 2 awareness rates between groups.

| Groups | N | X | SD | Source of variance | Sum of Squares | df | Mean Square | F | P |
|---|---|---|---|---|---|---|---|---|---|
| Disadvantaged Groups | 191 | 3,01 | 0,508 | B.G | 0,969 | 2 | 0,485 | 2,040 | ,131 |
| Non-Disadvantaged Groups | 718 | 3,06 | 0,455 | W.G. | 250,593 | 1055 | 0,238 | | |
| Transportation Disadvantaged Groups | 149 | 2,98 | 0,598 | Total | 251,562 | 1057 | | | |
| Total | 1058 | 3,04 | 0,488 | | | | | | |

There is no significant difference in people's satisfaction levels with intelligent transportation system applications among groups (F:2.040; p>0.05).

### 4.3.3. Decision and Interpretation of Hypothesis 3

There is a significant difference among people in terms of using or being aware of mobile applications related to Intelligent Transportation Systems.

Table 13. ANOVA results of Hypothesis 3 awareness rates between groups.

| Groups | N | X | SD | Source of variance | Sum of Squares | df | Mean Square | F | P | Significance |
|---|---|---|---|---|---|---|---|---|---|---|
| Disadvantaged Groups | 191 | 0,07 | 0,10 | B.G | 1,950 | 2 | 0,975 | 64,484 | ,001 | 2-1<br>3-1 |
| Non-Disadvantaged Groups | 718 | 0,18 | 0,12 | W.G. | 15,955 | 1055 | 0,015 | | | |
| Transportation Disadvantaged Groups | 149 | 0,17 | 0,14 | Total | 17,906 | 1057 | | | | |
| Total | 1058 | 0,16 | 0,13 | | | | | | | |

There is a significant difference among groups in terms of people's awareness of intelligent transportation system mobile applications (F:64.484; p<0.05). According to the results of the LSD test conducted to indicate which groups differ in terms of people's rates of using or being aware of smart transportation system mobile applications, it was found that the rate of using or being aware of these applications among non-disadvantaged groups (X:0.18) is higher than among disadvantaged groups (X:0.07). Additionally, the rate of using or being aware of smart transportation system mobile applications among transportation disadvantaged groups (X:0.17) is higher than among disadvantaged groups (X:0.07).

### 4.3.4. Decision and Interpretation of Hypothesis 4

There is a significant difference among individuals in terms of knowing or using intelligent transportation system applications while traveling.

Table 14. ANOVA results of Hypothesis 4 awareness rates between groups.

| Groups | N | X | SD | Source of variance | Sum of Squares | df | Mean Square | F | P | Significance |
|---|---|---|---|---|---|---|---|---|---|---|
| Disadvantaged Groups | 191 | 0,38 | 0,44 | B.G | 1,776 | 2 | 0,888 | | | |
| Non-Disadvantaged Groups | 718 | 0,49 | 0,26 | W.G. | 20,191 | 1055 | 0,019 | 46,412 | ,001 | 2-3,1<br>3-1 |
| Transportation Disadvantaged Groups | 149 | 0,44 | 0,35 | Total | 21,967 | 1057 | | | | |
| Total | 1058 | 0,46 | 0,32 | | | | | | | |

There is a significant difference among groups in terms of people's knowledge or use of intelligent transportation system applications while traveling (F:46.412; $p<0.05$). According to the results of the LSD test conducted to indicate which groups differ in terms of their knowledge or use of smart transportation system applications while traveling, it has been found that people in non-disadvantaged groups (X:0.49) are more aware of smart transportation system applications than those in transportation-disadvantaged (X:0.44) and disadvantaged groups (X:0.38). Additionally, it has been determined that people in transportation-disadvantaged groups (X:0.44) are more aware of smart transportation system applications than those in disadvantaged groups (X:0.38).

### 4.3.5. Decision and Interpretation of Hypothesis 5

There is a significant difference among groups in terms of using or knowing about intelligent transportation system applications while using public transportation.

Table 15. ANOVA results of Hypothesis 5 awareness rates between groups.

| Groups | N | X | SD | Source of variance | Sum of Squares | df | Mean Square | F | P | Significance |
|---|---|---|---|---|---|---|---|---|---|---|
| Disadvantaged Groups | 191 | 0,42 | 0,15 | B.G | 0,650 | 2 | 0,325 | 18,974 | ,001 | 2-3,1<br>3-1 |
| Non-Disadvantaged Groups | 718 | 0,49 | 0,12 | W.G. | 18,078 | 1055 | 0,017 | | | |
| Transportation Disadvantaged Groups | 149 | 0,46 | 0,13 | Total | 18,728 | 1057 | | | | |
| Total | 1058 | 0,47 | 0,13 | | | | | | | |

There is a significant difference in the rates at which people use or are aware of intelligent transportation system applications while traveling, depending on the groups they belong to (F: 18.974; $p < 0.05$). According to the results of the LSD test conducted to indicate which groups show differences in their rates of using or being aware of smart transportation system applications while traveling, it was found that the rate of awareness of non-disadvantaged individuals regarding smart transportation system applications (X: 0.49) was higher than that of transportation-disadvantaged individuals (X: 0.46) and disadvantaged individuals (X: 0.42). Additionally, the rate of awareness of transportation-disadvantaged individuals regarding smart transportation system applications while traveling (X: 0.46) was found to be higher than that of disadvantaged individuals (X: 0.42).

### 4.3.6. Decision and Interpretation of Hypothesis 6

There is a significant difference in the levels of using ITS applications by different groups throughout the day.

Table 16. ANOVA results of Hypothesis 6 awareness rates between groups.

| Groups | N | X | SD | Source of variance | Sum of Squares | df | Mean Square | F | P | Significance |
|---|---|---|---|---|---|---|---|---|---|---|
| Disadvantaged Groups | 191 | 1,92 | 0,48 | B.G | 5,423 | 2 | 2,711 | 9,064 | ,001 | 2-1<br>3-1 |
| Non-Disadvantaged Groups | 718 | 2,10 | 0,54 | W.G. | 315,584 | 1055 | 0,29 | | | |
| Transportation Disadvantaged Groups | 149 | 2,04 | 0,64 | Total | 321,007 | 1057 | | | | |
| Total | 1058 | 2,06 | 0,55 | | | | | | | |

There is a significant difference in the daily usage levels of ITS applications among groups (F: 9.064; $p < 0.05$). According to the results of the LSD test conducted to indicate which groups have differences in daily usage levels of AUS applications, it was found that the daily usage levels of AUS applications among non-disadvantaged groups (X: 2.10) were higher than those of disadvantaged groups (X: 1.92). Additionally, it was determined that the daily usage levels of AUS applications among transportation-disadvantaged groups (X: 2.04) were higher than those of disadvantaged groups (X: 1.92).

## 4.3.7. Decision and Interpretation of Hypothesis 7

There is a significant difference among groups in terms of using ITS applications to access their daily tasks on time.

Table 17. ANOVA results of Hypothesis 7 awareness rates between groups.

| Groups | N | X | SD | Source of variance | Sum of Squares | df | Mean Square | F | P | Significance |
|---|---|---|---|---|---|---|---|---|---|---|
| Disadvantaged Groups | 191 | 2,61 | 0,68 | B.G | 3,102 | 2 | 2,711 | 4,378 | ,013 | 2-3 |
| Non-Disadvantaged Groups | 718 | 2,70 | 0,55 | W.G. | 373,786 | 1055 | 0,29 | | | |
| Transportation Disadvantaged Groups | 149 | 2,56 | 0,67 | Total | 376,888 | 1057 | | | | |
| Total | 1058 | 2,67 | 0,59 | | | | | | | |

There is a significant difference among groups in terms of accessing their daily tasks in a timely manner by using ITS applications (F: 9.064; p<0.05). According to the results of the LSD test conducted to determine which groups differed in accessing their daily tasks on time by using AUS applications, it was found that individuals in non-disadvantaged groups had higher levels of accessing their daily tasks on time by using AUS applications (X: 2.70) compared to those in transportation-disadvantaged groups (X: 2.56). However, no significant difference was found between disadvantaged groups and either non-disadvantaged or transportation-disadvantaged groups.

### 4.3.8. Decision and Interpretation of Hypothesis 8

There is a significant difference among groups in terms of using ITS applications to make their journeys more comfortable.

Table 18. ANOVA results of Hypothesis 8 awareness rates between groups.

| Groups | N | X | SD | Source of variance | Sum of Squares | df | Mean Square | F | P | Significance |
|---|---|---|---|---|---|---|---|---|---|---|
| Disadvantaged Groups | 191 | 2,64 | 0,66 | B.G | 7,510 | 2 | 3,755 | 10,761 | ,001 | 1-3<br>2-3 |
| Non-Disadvantaged Groups | 718 | 2,73 | 0,53 | W.G. | 368,147 | 1055 | 0,34 | | | |
| Transportation Disadvantaged Groups | 149 | 2,49 | 0,73 | Total | 375,657 | 1057 | | | | |
| Total | 1058 | 2,68 | 0,59 | | | | | | | |

There is a significant difference among groups in terms of people's comfort during travels with ITS applications (F:10.761; p<0.05). According to the LSD test results conducted to indicate which groups differ in terms of their comfort during travels with AUS applications, it has been found that disadvantaged groups (X:2.64) are more comfortable than non-disadvantaged groups (X:2.73) with AUS applications during travels. Additionally, it has been observed that non-disadvantaged groups (X:2.73) are more comfortable than transportation-disadvantaged groups (X:2.49) with AUS applications during travels.

### 4.3.9. Decision and Interpretation of Hypothesis 9

There is a significant difference among groups in terms of the economic (financial) impact of people using ITS applications.

Table 19. ANOVA results of Hypothesis 9 awareness rates between groups.

| Groups | N | X | SD | Source of variance | Sum of Squares | df | Mean Square | F | P | Significance |
|---|---|---|---|---|---|---|---|---|---|---|
| Disadvantaged Groups | 191 | 2,40 | 0,88 | B.G | 21,606 | 2 | 10,803 | 12,253 | ,001 | 1-2,3 |
| Non-Disadvantaged Groups | 718 | 2,02 | 0,94 | W.G. | 930,171 | 1055 | 0,88 | | | |
| Transportation Disadvantaged Groups | 149 | 2,09 | 0,96 | Total | 951,777 | 1057 | | | | |
| Total | 1058 | 2,10 | 0,94 | | | | | | | |

There is a significant difference among groups regarding the economic impact of people using ITS applications (F:12.253; p<0.05). According to the results of the LSD test conducted to indicate which groups differ in terms of the economic impact of AUS applications, it has been determined that disadvantaged groups (X:2.40) have a higher impact than transportation-disadvantaged groups (X:2.09) and non-disadvantaged groups (X:2.02) in terms of the economic impact of AUS applications.

### 4.3.10. Decision and Interpretation of Hypothesis 10

There is a significant difference in terms of the positive contribution of ITS applications in daily life among different groups.

Table 20. ANOVA results of Hypothesis 10 awareness rates between groups.

| Groups | N | X | SD | Source of variance | Sum of Squares | df | Mean Square | F | P | Significance |
|---|---|---|---|---|---|---|---|---|---|---|
| Disadvantaged Groups | 191 | 2,61 | 0,71 | B.G | 4,938 | 2 | 2,469 | 6,138 | ,002 | 2-1,3 |
| Non-Disadvantaged Groups | 718 | 2,73 | 0,57 | W.G. | 424,355 | 1055 | 0,40 | | | |
| Transportation Disadvantaged Groups | 149 | 2,56 | 0,76 | Total | 429,293 | 1057 | | | | |
| Total | 1058 | 2,68 | 0,63 | | | | | | | |

There is a significant difference among groups in terms of the positive contribution of ITS applications in daily life (F:6.138; p<0.05). According to the results of the LSD test, which was carried out in order to indicate between which groups people differ in the positive contribution of AUS applications in daily life; It has been determined that people in non-disadvantaged groups are more likely to have a positive contribution from ITS applications in daily life (X:2.73) than people in disadvantaged groups (X:2.61) and people from disadvantaged groups (X:2.56).

### 4.3.11. Decision and Interpretation of Hypothesis 11

There is a significant difference among groups in terms of experiencing problems while using ITS applications.

Table 21. ANOVA results of Hypothesis 11 awareness rates between groups.

| Groups | N | X | SD | Source of variance | Sum of Squares | df | Mean Square | F | P | Significance |
|---|---|---|---|---|---|---|---|---|---|---|
| Disadvantaged Groups | 191 | 0,08 | 0,27 | B.G | 6,431 | 2 | 3,215 | 20,876 | ,001 | 2-3<br>3-1,2 |
| Non-Disadvantaged Groups | 718 | 0,20 | 0,40 | W.G. | 162,489 | 1055 | 0,154 | | | |
| Transportation Disadvantaged Groups | 149 | 0,36 | 0,48 | Total | 168,920 | 1057 | | | | |
| Total | 1058 | 0,20 | 0,40 | | | | | | | |

There is a significant difference among groups in terms of experiencing problems while using ITS applications (F:20.876; $p<0.05$). According to the results of the LSD test, which was carried out to indicate which groups differ in terms of people having problems while using ITS applications; It has been determined that people in non-disadvantaged groups have more problems using ITS applications (X: 0.20) than people in transportation disadvantaged groups (X: 0.36). In addition, it has been determined that people in transportation disadvantaged groups are more likely to have a positive contribution from ITS applications in daily life (X: 0.36) than people in non-disadvantaged groups (X: 0.20) and people in disadvantaged groups (X: 0.08).

A brief summary of all hypotheses is given in the table below. If the P value is less than 0.5 it is significant, if it is greater than 0.5 it is not significant. It shows the significance between the groups in the Significance values. 1: Disadvantaged groups, 2: non-disadvantaged groups, and 3: Transportation disadvantaged groups.

Table 22. Hypothesis Results of the Anova Test in General

| **Hypotheses** | **P** | **Significance** |
|---|---|---|
| Hypothesis 1 | 0,001 | 2-1,3<br>3-1 |
| Hypothesis 2 | 0,131 | 0 |
| Hypothesis 3 | 0,001 | 2-1<br>3-1 |
| Hypothesis 4 | 0,001 | 2-3,1<br>3-1 |
| Hypothesis 5 | 0,001 | 2-3,1<br>3-1 |
| Hypothesis 6 | 0,001 | 2-1<br>3-1 |
| Hypothesis 7 | 0,013 | 2-3 |
| Hypothesis 8 | 0,001 | 1-3<br>2-3 |
| Hypothesis 9 | 0,001 | 1-2,3 |
| Hypothesis 10 | 0,002 | 2-1,3 |
| Hypothesis 11 | 0,001 | 2-3<br>3-1,2 |

## 4.4. Discussion

According to this study, the effects of ITS applications on disadvantaged and transportation-disadvantaged groups have been examined in the following sentences.

- Disadvantaged groups have expressed overall satisfaction with ITS applications but have also stated that they are not very satisfied. Additionally, most people reported using these applications "1-2 times" per day or "not at all." Disadvantaged groups mostly use rail systems and buses for transportation, with their own private vehicles and walking as their second priorities. The reason for not using private vehicles is the high traffic and parking problems, as well as the fact that public transportation is free. Furthermore, individuals want to minimize their use of private vehicles due to the recent increase in fuel costs. The use of buses and rail systems leads to longer travel times and individuals get tired when they go outside. Therefore, they want to minimize their trips outside and only leave the house for important reasons.
- The concept of ITS is unfamiliar to disadvantaged groups. Additionally, elderly individuals in these groups cannot use ITS mobile applications because they do not have smartphones, and those who do have smartphones do not know how to use the applications. Half of those who know about the ITS concept and use mobile applications only use map applications. The applications they use while traveling or using public transportation are those, they are familiar with from their daily lives or those that have become habitual or necessary for them. However, they report that some applications, such as smart stops, smart pedestrian buttons, and journey display screens, do not work.
- Disadvantaged groups report that they do not have problems using the applications during their travels and mostly have comfortable journeys. They have stated that they mostly see positive effects on their daily lives. However, they have emphasized that this is mostly during non-peak traffic hours. They report serious traffic and parking problems during their journeys, inadequate public transportation schedules and delayed arrivals, inadequate pedestrian and bicycle paths, and the use of old-style public transportation in certain areas. Due to heavy traffic and inadequate schedules, public transportation often exceeds its capacity, making it difficult for individuals to travel comfortably during peak hours.

- Transportation disadvantaged groups are the highest group that express their dissatisfaction with ITS applications. Transportation disadvantaged groups consist of both disadvantaged and non-disadvantaged individuals. Generally, there are 12.50% disadvantaged individuals. They are composed of working individuals or individuals with disabilities and elderly people, and usually travel for work/school. Since they are composed of working or studying individuals, they need to travel by rail systems and buses, and their journeys take between 30-60 minutes. The primary reason for this is the traffic congestion during work entry and exit hours.
- Transportation disadvantaged groups generally know and actively use ITS applications during the day. However, they experience difficulties in accessing their work on time, have problems while using applications, and feel that their positive contributions are minimal. They generally use the applications used in public transportation in their daily lives. They see an economic impact because they use public transportation. This impact is due to free use for disadvantaged groups, and for other individuals, traveling with less cost than traveling by car.
- Transportation disadvantaged individuals experience problems during their travels due to traffic congestion and inadequacy of public transportation vehicles. As a result, it is seen that they have difficulties in using mobile applications, especially when traffic congestion starts. The situations that individuals feel disadvantaged are generally accessibility, mobility, and cost. They experience access and mobility problems from one point to another. The reason for this is the population increase caused by the influx of a large number of immigrants to the city of Izmir in recent years, resulting in traffic congestion, public transportation vehicles carrying more passengers than their capacity, increasing the transfer points of Izmir bus transportation, and the limited schedules of public transportation vehicles.

## 4.5. Proposed Intelligent Transportation Systems Elements for the Study Area

- Increasing the number of camera systems in different angles at the existing points and placing them in many different non-existent locations in the city of Izmir,
- Expanding the use of The Parking Guidance System (PGS) provided by IZUM and increasing the number of informed parking areas,
- Installing the Green Man+ application on smart pedestrian crossing systems, which is a system that prolongs the crossing time for disadvantaged individuals.
- Inspecting and repairing or replacing faulty smart pedestrian buttons and customizing them to be audible for people with disabilities,
- Fixing the malfunctions of smart stops and installing new ones at non-existent stops where necessary, as many smart stop devices that display bus schedules are not available at several stops or are not working properly.
- Although the Hakverdi (2021) study was conducted for disabled individuals, it can also be an inclusive study that covers the elderly and other disadvantaged groups. This study can help determine the number of disadvantaged individuals waiting at stops and which bus they are waiting for. Additionally, stop congestion may not be observed with camera systems at stops. This can help resolve issues with transportation schedules.
- Developing policies to facilitate the use of WeWalk Smart Cane and Horus Smart Vision System applications for disabled individuals.
- Developing user-friendly applications for the daily lives of elderly and non-smartphone users that can be used physically rather than mobile and web applications.
- Some of the passenger information boards placed for passenger information purposes in public transport systems do not work. It should also add voice information feature of passenger information boards.

As a result of the analysis, the Quick Response Look-up Table was revealed in Table 23. In the table, ITS elements for the problems of disadvantaged individuals are suggested. Accordingly, used, and unused applications in İzmir are separated. Existing applications that can be actively used are reserved. Then, it was shown which applications can be used by elderly and disabled individuals.

Table 23. Quick Response Look-up Table

| **Problems** | **Intelligent Transportation System Elements** | **Existing applications in Izmir** | **Applications with Usage Problems** | **Most useful apps** |
|---|---|---|---|---|
| Mobility | 3. Smart Pedestrian Button<br>5. IZUM<br>7. Green Man+<br>8. Barrier-Free Intelligent Transportation<br>9. WeWalk<br>10. Horus | Yes<br>3,5,7,9,10 | Yes<br>3,5 | for the elderly:<br>3,7,8 |
| | | No<br>7,8, | | for the disabled:<br>7,8,9,10<br>For the visually impaired:<br>8,9,10<br>For the Deaf people:<br>5,7,8 |
| Accessibility | 2. Passenger Information boards<br>3. Smart Pedestrian Button<br>4. Map Applications<br>7.Green Man+<br>8. Barrier-Free Intelligent Transportation | Yes<br>2,3,4 | Yes<br>2,3,4 | for the elderly:<br>2,3,7,8 |
| | | 7,8 | | for the disabled:<br>2,7,8<br>For the visually impaired:<br>7,8<br>For the Deaf people:<br>2,7,8 |
| Informing / Obtaining Information | 1.Smart Stop<br>4. Map Applications<br>5.IZUM<br>6.ESHOT Mobile/Web<br>8. Barrier-Free Intelligent Transportation<br>9.WeWalk | Yes<br>1,4,5,6,9,10 | Yes<br>1,4,5,6 | for the elderly:<br>1,8, |
| | | No<br>8 | | for the disabled:<br>1,8,9,10 |

**(cont. on next page)**

**Table 23. (cont.)**

| | | | | |
|---|---|---|---|---|
| | 10. Horus | | | For the visually impaired: 8,9,10<br>For the Deaf people: 1,8 |
| Usage Problems | 1. Smart stop<br>3. Smart Pedestrian Button<br>4. Map Applications<br>6.ESHOT Mobile | Yes<br>1,3,4,6 | Yes<br>1,3,4,6 | for the elderly: 1,3<br>for the disabled: 1,3 |
| Travel quality and comfort | 2. Passenger Information Boards<br>3. Smart Pedestrian Button<br>8. Barrier-Free Intelligent Transportation<br>9.WeWalk<br>10. Horus<br>11.New public transport vehicles | Yes<br>2,3,9,10,11<br>No<br>8 | Yes<br>2,3,11 | for the elderly: 2,3,8,11<br>for the disabled: 2,3,8,9,10,11<br>For the visually impaired: 2,8,9,10<br>For the Deaf people: 8,11 |

# CHAPTER 5

# CONCLUSION

Throughout history, mankind has developed many modes of transportation to go from one place to another. First, pedestrian was used, then animal power, wind power, waterways, and steam power with the industrial revolution. As a result of these developments, economic, cultural, social, and environmental problems have emerged due to traffic congestion. In order to eliminate these problems, it is necessary to get help from electronic, information and communication technologies. This is where ITS comes in. In addition, it should be prioritized that those who are affected by the negative aspects of transportation and cannot make use of it properly, especially the disadvantaged groups, benefit from ITS applications to the maximum extent. Accordingly, the extent to which disadvantaged groups are affected by and can benefit from ITS practices should be well researched. Within the scope of the study, category analysis was used to observe the effect of ITS applications. In the category analysis, individuals were divided into 3 groups as disadvantaged, transportation disadvantaged and non-disadvantaged groups. The effects of ITS applications on disadvantaged and transportation disadvantaged groups are very important.

ITS applications are a growing sector with the developing technologies in transportation in recent years. They are effective and practical applications in the travels of individuals. However, such practices are insufficient for disadvantaged groups. There are various deficiencies in the literature regarding the examination of transportation planning for disadvantaged groups. This thesis contributes to closing this gap and drawing attention to the situation of disadvantaged groups in transportation planning. For this reason, it is expected to form a basis and guide the plans made in the discipline of urbanism. Yet, there are not enough studies on the effects of ITS applications on disadvantaged users. This study aims to fill this gap in the literature.

It should be prioritized that disadvantaged groups get the maximum benefit from ITS applications. Accordingly, the extent to which disadvantaged groups are affected and benefited from ITS applications should be well investigated. It is one of the most important issues to enable people with disadvantages to actively use ITS applications.

ITS applications for their disadvantages need to be rearranged or applications for disadvantaged people can be developed. But it is important to make more efforts to promote these applications.

According to the hypothesis results, all groups stated that they were satisfied with ITS applications, disadvantaged groups did not know the concept of ITS and had problems using mobile applications. As a result of all analyzes, new projects have been developed for disadvantaged groups in the world and in our country, and suggestions have been developed according to the problems. In addition, passenger information systems, smart stops, smart pedestrian crossing systems and map applications in the region should be developed.

ITS are developed to enable people to travel more safely and comfortably through various information and communication technologies in transportation. In this process, it is desired to show the problems that people with disadvantages have experienced in transportation. In addition, it is aimed to address the problems of individuals who do not have a disadvantage but feel disadvantaged in transportation. According to the results, there are few applications developed for disadvantaged groups in our country. Turkey can try to solve the problems they encounter in transportation by using the applications developed for disadvantaged groups in the world.

In the light of all this information, it is seen that disadvantaged and transportation disadvantaged individuals experience significant problems while using ITS applications. Many countries in the world make investments for disadvantaged individuals in ITS applications. In our country, this issue has been mentioned in transportation strategies, but more investment needs to be directed in project development.

The results of this study cannot be generalized to the whole of İzmir. Because neighbourhoods with equal opportunities in terms of transportation systems were selected. Regions of İzmir province that are inadequate in terms of transportation systems can also be included in the study. In this way, suggestions can be developed that can appeal to the whole of Izmir. In addition, the study can be expanded by interviewing more disabled people. Thus, more information can be obtained about disadvantaged individuals.

In our country, studies are carried out in many provinces in terms of ITS applications. Studies can be carried out in regions with various ITS applications. Thus, comparison can be made in terms of the use of ITS applications. These studies contribute to the development of new applications in the field of ITS. New projects can be developed for disadvantaged individuals.

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# APPENDIX

**İZMİR YÜKSEK TEKNOLOJİ ENSTİTÜSÜ**
**MİMARLIK FAKÜLTESİ ŞEHİR VE BÖLGE PLANLAMA BÖLÜMÜ**
**İZMİR ŞEHRİ İÇİN ULAŞIM ANKETİ**

Tarih:
Anketi uygulayan kişi:

| | |
|---|---|
| Hane no: Mahalle:<br>Hane kişi sayısı: Hane araç sayısı:<br>Hanede Engelli veya 65 yaş üstü kişi: ☐Var ☐Yok (Varsa kaç kişi?.....)<br>E-posta ve/veya Cep telefonu: | **Anket çalışmasında Akıllı Ulaşım Sistemleri uygulamalarının bireyler üzerindeki etkisi incelenmektedir. Bu çalışma Yüksek lisans tezi ve Bilimsel Araştırma Projesi kapsamında veri olarak kullanılacaktır. Bu çalışma hane halkındaki bireylere yöneliktir. 13 yaş altındaki çocuklara ve ayağa kalkamayan 65 yaş üstü kişilere anket yapılmayacaktır.** |

1.Dezavantajlı durumuzun nedir?

☐ Zihinsel Engelli ☐ Görme engelli ☐ Bedensel Engelli ☐ İşitme Engelli ☐ Konuşma ve Dil Engelli ☐ Diğer
☐ 65 yaş üstü

2.Genelde Yolculuklarınızda Hangi Ulaştırma Sistemlerini Kullanıyorsunuz?

☐ Otobüs ☐ Minibüs ☐ Özel Araç ☐ Raylı sistemler ☐ Deniz Ulaşımı ☐ Bisiklet ☐ Taksi ☐ Motosiklet ☐ Yaya

3.Yolculuklarınızı genellikle ne amacıyla yapıyorsunuz?

☐ İş/okul ☐ Sosyal/Gezme/Ziyaret ☐ Alışveriş ☐ Hepsi

4.Yapılan yolculuğun ortalama süresi kaç dakikadır? (Aktarmalarla birlikte)

☐ 30 dakikadan az ☐ 30-60 dakika ☐ 60-90 dakika ☐ 90 dakikadan fazla

5.Akıllı ulaşım sistemlerinin uygulamalarından haberdar mısınız? (Ulaşım Cep uygulamaları, Belediye cep uygulamaları, Navigasyonlar vb.)

☐ Evet ☐ Hayır

6.Akıllı ulaşım sistemlerinin mobil uygulamalarını kullanıyor musunuz? Kullandıklarınızı işaretleyiniz.

| | |
|---|---|
| ☐ KGM Türkiye Trafik | ☐ İzmir BB Cep |
| ☐ İZUM | ☐ Cep Harita, Yandex Haritalar |
| ☐ ESHOT Mobil | ☐ Bisim Mobil |
| ☐ Bizİzmir | ☐ Kent Kart Mobil |
| ☐ İzmir Tarih | ☐ Acil İzmir |
| ☐ Diğer (…………………….……) | |

7.Seyahat halindeyken akıllı ulaşım sistemlerinden hangilerini kullanıyorsunuz/biliyorsunuz? Kullandıklarınızı/Bildiklerinizi işaretleyiniz.

| | |
|---|---|
| ☐ HGS, OGS, KGS | ☐ ESHOT Cep/Web Uygulaması |
| ☐ Akıllı Otopark Bilgilendirme panosu | ☐ İzmir BB Cep/Web Sitesi |
| ☐ Akıllı Yaya Geçitti Butonu | ☐ İZUM |
| ☐ Moovit | ☐ Sürücü Bilgilendirme Tabelası |
| ☐ Duraklardaki sefer görüntüleme ekranı | ☐ Diğer (…………………….……) |

8.Toplu taşımadaki akıllı ulaşım sistemlerinden hangilerini kullanıyorsunuz/biliyorsunuz? Kullandıklarınızı/Bildiklerinizi işaretleyiniz.

| | |
|---|---|
| ☐ Duraklardaki sefer görüntüleme ekranı | ☐ Akıllı Yaya geçitti Butonu |
| ☐ Yolcu Bilgi Panosu | ☐ ESHOT |
| ☐ Moovit | ☐ İzmir BB Cep |
| ☐ Bizİzmir | ☐ Kent Kart |
| ☐ Bisim | ☐ Diğer (…………………….……) |

9.Akıllı ulaşım sistemleri uygulamalarından ne derece memnunsunuz?

☐ Çok memnunum ☐ Memnunum ☐ Memnun Değilim ☐ Hiç Memnun Değilim

10.Yolculuklarınızda günde kaç kere bu uygulamaları kullanıyorsunuz?

☐ Günde 5'ten fazla ☐ Günde 3-4 kere ☐ Günde 1-2 kere ☐ Hiç kullanmıyorum

11.Bu uygulamalar işinize zamanında erişmenizi sağladı mı?

☐ Evet ☐ Kısmen ☐ Hayır

12.Bu uygulamalarla birlikte yolculuklarınızı rahat bir şekilde yapıyor musunuz?

☐ Evet ☐ Kısmen ☐ Hayır

13.Bu uygulamalar sizlere ekonomik(maddi) olarak bir etkisi oldu mu?

☐ Evet ☐ Kısmen ☐ Hayır

14.Bu uygulamalar günlük yaşantınızı olumlu bir katkısı oluyor mu?

☐ Evet ☐ Kısmen ☐ Hayır

15.Bu uygulamaları kullanırken problem yaşıyor musunuz?

☐ Evet ☐ Hayır

16.Kendinizi ulaşımda dezavantajlı hissediyor musunuz? Ne açıdan? (Ulaşımda Dezavantajlılar, erişilebilirlik, hareketlilik, maliyet, kolaylık ve bilgiye erişim gibi konularda yeterli hizmeti alamayan kişilerdir.)

☐ Evet (……………………………………………………….) ☐ Hayır

17.Ulaşımda karşılaştığınız en önemli problemler nelerdir?

☐ Otopark Sıkıntısı ☐ Yaya ve bisiklet yolları sıkışıklığı

☐ Hava ve ses kirliliği ☐ Toplu taşıma araçlarının yetersizliği

☐ Trafik Sıkışıklığı ☐ Toplu taşıma araçlarının eski tip olması

☐ Diğer (……………………………………………………….)

18.Ulaşımda neyin düzeltilmesini beklersiniz?

……………………………………………………………………………………………………………………………………………………….

……………………………………………………………………………………………………………………………………………………….

Çalışmaya katılımınızın için teşekkür ederiz.